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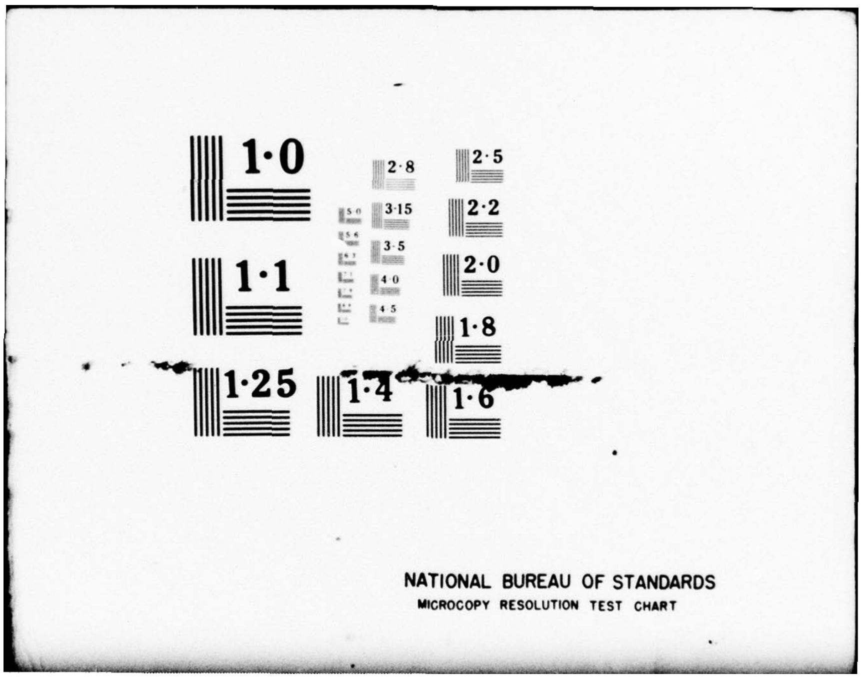
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Wright-Patterson Air Force Base, Ohio

AN ANALYSIS OF THE RELATIONSHIP BETWEEN JOB SATISFACTION AND LABOR PRODUCTIVITY AS MEASURED ACROSS LINE ITEMS WITHIN AN ORGANIZATION

THESIS

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PREFACE

This thesis analyzes the relationship between job satisfaction and productivity across an organization. Specifically, the organization involved was the Aerospace Guidance and Metrology Center, located at Newark AFS, Ohio.

I am deeply indebted to many people for their assistance in my thesis effort. Primarily, I must thank my advisor, Dr. Joseph P. Cain, for his guidance and most of all his patience. I also thank Mr. Jerry Anderson, Mr. Jim Dickenson, Mr. Roger Benley, and Mr. Doug Franga, and others of the Aerospace Guidance and Metrology Center who provided valuable assistance in administering the job satisfaction questionnaire and collecting production data. A special thanks goes to those individuals who took time to complete the questionnaire and provided additional information. I would also like to thank Major Saul Young, Ph.D., for his assistance as thesis reader.

Above all, I would like to thank my wife, Christina, who typed this thesis and aided immensely in its completion.

Donny Ray Jones

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ABSTRACT

The relationship between job satisfaction and productivity is one that has received considerable attention recently. Developing a method of measuring this relationship across an organization, without interrupting the production process, requires a careful analysis of available information. This thesis studied the Aerospace Guidance and Metrology Center, Newark AFS, Ohio.

Production data in the form of units produced, direct labor hours, and direct material costs (in 1967 dollars) were used. The production data used covered twenty(20) line items that are repaired at Newark AFS. This production data was used to develop production functions. Through the use of regression techniques, marginal products were determined. These marginal products were then standardized, in order to reduce the effect of the magnitude of the values involved, putting the marginal products in the form of elasticities.

A questionnaire was developed so that a measure of job satisfaction could be derived, to be used in the final analysis.

In the final analysis the marginal products were used with the job satisfaction questionnaire responses to determine what type, if any, relationship there was between job satisfaction and productivity, as measured at Newark AFS.

CHAPTER 1
INTRODUCTION

STATEMENT OF THE PROBLEM

Increasing productivity through the use of various job enrichment programs has received much notoriety in recent years. One of the most notable examples of an organization buying an extensive job enrichment program has been the Air Force Logistics Command (AFLC), which is presently implementing Dr. Frederick Herzberg's Orthodox Job Enrichment (OJE) program in its repair depots. An assumption implicitly made when an Orthodox Job Enrichment program is instituted is that workers whose jobs have been enriched are in some sense "more productive" as a result. This thesis will address the question, "Is there any relationship between job satisfaction and productivity?"

BACKGROUND

There has been a great deal of research in the area of job satisfaction and its relationship or lack of relation to the productivity of the workers affected by a job enrichment program. The findings vary from being strongly supportive of the existence of a positive correlation between job satisfaction and productivity to being equally assertive that there is absolutely no relationship between the two, other than that attributable to chance. However, it is the possibility of a positive correlation between

job satisfaction and productivity that has prompted the Air Force Logistics Command to begin implementing an Orthodox Job Enrichment program at its major repair depots. To shed some light on the reason that the Air Force Logistics Command has felt it necessary to implement job enrichment, it should be noted that, ". . .if a worker perceives his job as dull, there is no reason to presume that more pay, more benefits, better treatment, a union, more information, more vacation, and more holidays will make the job itself any less boring." (Foulkes, 1969: 23-24). Yet, if somehow the basic job can be changed, the concerns of the worker might also change. In these times of dwindling budgets and increasing commitments, there is a need for obtaining more from less.

Yet, it must be realized that, in many instances, it may be impossible to add to specific jobs the type of decision-making for which Orthodox Job Enrichment calls, simply due to the technology of the work involved (Perspectives, 1975: 55). If, for example, a worker is rotated to different jobs rather than riviting the same place on a wing slat, job rotation has taken place. While job rotation may be one of several techniques used to enrich a job, it is not, used alone, job enrichment.

In light of this, the Systems Management Department of the Air Force Institute of Technology (AFIT) has been tasked to measure the effectiveness of the job enrichment programs being implemented at the various repair depots.

This research effort is designed to ascertain whether there is any relationship between a rise in job satisfaction and an associated increase in worker productivity.

OBJECTIVES

The objectives of this research are as follows:

1. To develop a method of estimating a measure of job satisfaction of workers.

2. To develop an approach for examining and comparing production data to this measure of job satisfaction.

SCOPE AND APPLICATION

A job satisfaction assessment and historical production data were used to determine whether there is a correlation (presumably positive) between job satisfaction and productivity. It was necessary to devise a method to quantify the degree of job satisfaction in relation to specific items of production or end items. This measure was employed to determine whether there was a positive or negative correlation between job satisfaction and productivity, or whether any relationship was merely coincidental.

Since this was not a before-and-after type research effort, no attempt was made to actually implement a job enrichment or similar program to affect job satisfaction. It was necessary to develop an alternate method of testing for correlation. In light of this restriction, the study was conducted across an organization in such a way that

segregated production data could be compared with identifiable results from a job satisfaction assessment. This assessment (see Appendix B) consisted of questions designed to identify the specific end item(s) the individual worked with and his degree of job satisfaction.

The production data, historical in nature, was used to develop a workable predictive model through least squares regression techniques, using a Cobb-Douglas production function for each end item. From these production functions, marginal products of labor were derived. An attempt was made to test the hypothesis of whether there exists any relationship between our measure of labor productivity and our measure of job satisfaction.

ASSUMPTIONS

Raw data figures from the production reports were accepted as being accurate. Also, while workload varied due to external factors, it was assumed that it would have smoothed over time. Lastly, answers to the job satisfaction assessment were taken to be genuine.

DEFINITIONS

Throughout this thesis, a number of terms are used repeatedly; such as, Direct Labor Hours, Direct Material, and End Item. To facilitate readability, a list of these terms and definitions are described in Appendix A.

CHAPTER 2
APPLICATIONS, SUCCESSES AND FAILURES

INTRODUCTION

As mentioned in the previous chapter, there have been many studies on or about job enrichment and what it does or does not achieve. Borrowing from and expanding on the definition of job enrichment, it should be noted that jobs are enriched through redesigning or restructuring them to provide greater opportunity for individual freedom in performing the job and to make the content more interesting. Job enrichment is actually many things: a set of principles concerning how a job should be accomplished; the techniques needed to apply restructuring methods in an attempt to assure that the job is accomplished in the desired manner; a set of assumptions about people; and a philosophy of management. It is a powerful management tool, which is readily available for channeling peoples' energy in the directions of achievement, accomplishment, and growth. In a more general sense, job enrichment can be viewed as a "management tool" for providing a more realistic organizational environment in which each individual will achieve a greater degree of satisfaction and at the same time will contribute more to the organization. Yet if the job enrichment does not cause a permanent rise in job satisfaction, and if the rise in job satisfaction does not cause a rise in worker productivity, job enrichment

cannot be a "management tool." In this case, job enrichment would be viewed as simply a stop-gap measure.

Job enrichment is not, however, a panacea for all of the ills of management. While Dr. Herzberg had originally intended job enrichment as a means of increasing workers' satisfaction and motivation along with productivity, Jansen asserts that job enrichment is now, ". . .being acclaimed in the popular press as a cure for problems ranging from inflation to drug abuse." (Jansen, 1975: 57). As will be demonstrated, many of the "failures" of job enrichment have been due to inadequate diagnosis of the original problem on the part of the policy-makers of the organization.

First, job enrichment techniques available for use by today's managers will be discussed. Several examples of "successful" attempts at implementing job enrichment will then be presented, accompanied by a discussion concerning possible reasons for the successes. Lastly, the question of why job enrichment fails and some reasons for these failures will be examined.

SETTING

What better subject to begin a study of the setting of the "successes and failures" of job enrichment applications than Dr. Herzberg's Adam? As defined in Work and the Nature of Man (Herzberg, 1971: 15), Adam represented the "feeble-minded" man created without knowledge who, in time, was followed by Abraham who represented capable man with

innate potential. The Calvinists, who espoused the belief that "the Elect must participate in the affairs of this world" provided the link between the Adam-Abraham view of man and the concept of work as a vocation in which man served God--the eternal Protestant Ethic (Ibid: 23). The precept of scientific management and the extinction of the law of individual differences came with industrialization. The fact that the concept of scientific management de-emphasized the role of the individual lead Mayo to conclude that one of the greatest faults of the Industrial Revolution was that it alienated the worker from most of the experiences he held to be significant in life (Ibid: 38). Dr. Herzberg, in an early study involving computer-machine programmers, related high turnover and lack of morale on the part of the programmers to the routine drudgery of programming which inevitably followed soon after the initial challenge of learning the particular task had been met. The assembly-line personnel of blue-collar workers in today's society are in the same cirsumstance as were the computer-machine programmers studied by Dr. Herzberg. When drudgery sets in, the machine loses its status as an instrument for the human's determinism. Instead of being determined by its operator, the machine becomes an instrument to determine the operator (Ibid: 25). In another study, the problem of worker dissatisfaction and sagging productivity was identified as being a case of ". . .asking smarter people to do dumber jobs, jobs that don't challenge them to work

at levels they can achieve." ("Boosting output by cutting drudgery," 1977: 25).

SUCCESSES

Through his studies, Dr. Herzberg was able to establish his Two-Factor-Theory model in which he attempted to explain what really motivated people. Dr. Herzberg advanced this theory to aid in solving problems in the area of manpower. Essentially, the two-factor-theory states that the factors involved in producing job satisfaction are separate and distinct from the factors which lead to job dissatisfaction. Dr. Herzberg noted that when the "dissatisfiers" are eliminated, job dissatisfaction is no longer present, but job satisfaction is not necessarily present simply because dissatisfaction is absent. He also noted that if job satisfaction <u>is</u> present simply because job dissatisfaction has been eliminated, the satisfaction will be only temporary in nature. Herzberg concluded that, in order to achieve any degree of satisfaction and motivation, the fulfillment of hygiene factors must be assured before emphasis can be placed on the satisfiers, or motivators. A partial list of motivators and hygiene factors might include:

Motivators	Hygiene
1. Achievement	1. Supervision
2. Recognition for achievement	2. Company policy
3. Work itself	3. Working conditions
4. Responsibility	4. Status
5. Advancement	5. Job security
6. Possibility of growth	6. Salary

(Herzberg, 1971)

Further, Dr. Herzberg states in his article "The Wise Old Turk" (Herzberg, 1974: 70-80) that the original intent of job enrichment is, "the installation of motivator factors into an individual job." In this article, Dr. Herzberg described Orthodox Job Enrichment as being, ". . .based on observed relationships between ability and both potential and opportunity and on results of performance reinforcement." (Ibid). In order to insure that the rise in productivity is permanent, this two-factor-theory must be integrated into a systematic motivation program which is implemented through direct changes in the work itself.

Along the same lines, Robert N. Ford agreed to do a study with AT&T in an attempt to determine whether the work itself could be used as a motivator. The study was aimed at a reduction in that company's employee turnover. For twenty-five years, AT&T had been seeking a way to motivate employees in order to increase productivity and quality, reduce costs and turnover, and improve employee morale. These attempts included reduced hours and longer vacations, increased wages and benefits, profit sharing, and a host of others. Yet, while these programs worked initially, they failed to produce a satisfactory and lasting solution (Ford, 1969: 22). From Ford's viewpoint, Dr. Herzberg's two-factor-theory was supported in the redesigning of the work which he accomplished at AT&T.

In regards to implementing job enrichment programs, Hackman's guidelines seem to be the most enlightening.

These guidelines are as follows:

1. Key individuals responsible for the work redesign project attack the especially difficult problems from the start.

2. Management ensures that a diagnosis of the changes needed in the target jobs, based on some articulated theory of work redesign, is conducted before implementation.

3. Management ensures that specific changes are publicly discussed and are explicitly based on the diagnosis.

4. Those responsible for the work redesign project are prepared to evaluate the project continuously throughout its life.

(Hackman, 1975: 130-137).

One should think that, once armed with these guidelines, an organization could not possibly "go wrong." Yet, in an article in Personnel, E. Lauck Parke stated that he felt that there was still another step to be added. In his argument concerning self-actualization, Parke states, ". . .to make job enrichment successful, it must be properly designed to include the control mechanisms of accountability for performance and material rewards for output that meets or exceeds clear-cut standards."(Parke, 1975: 20). Once again, while Parke feels job enrichment is a viable theory, he feels that the emphasis is not quite on the "right" area and that it should be shifted.

In closing this discussion concerning those who prescribe job enrichment, it should be noted that while job enrichment, ". . .represents a potentially powerful strategy for change that can help an organization achieve their goals for higher quality work--and at the same time further the

equally legitimate needs of contemporary employees for more meaningful work experience . . . the effectiveness of job enrichment is likely to be enhanced when the tasks of diagnosing and changing jobs are undertaken collaboratively by management and by the employees whose work will be affected." (Jansen, 1975: 70).

FAILURES

The previous illustrations demonstrate that, when the work structure is properly diagnosed, and when the particular job enrichment plan is properly drawn up, implemented, and supported, worker satisfaction as well as some measure of productivity can be increased. Although it has been shown that job enrichment is capable of increasing satisfaction and productivity, it must be realized that positive or negative, or no results can be expected from a program of job enrichment. The type of result depends a great deal upon the motivations of the work force involved (Maher, 1971). One should also realize that, even though policy-makers would like to think that job satisfaction and productivity are causally linked, that is, because job satisfaction increases, productivity automatically increases (or vice versa), the data shows that these two states do not always follow a parallel path. To date, it has not been conclusively proven that job enrichment is powerful enough to affect both productivity and satisfaction significantly. It has been shown, however, that production is affected by the level of worker motivation in addition to job satisfaction.

These two factors seem to be the common denominator of productivity and the quality of working life (Katzell, 1975: 69). When the various combinations of satisfaction and motivation (motivated-not satisfied, motivated-satisfied, satisfied-not motivated, not satisfied-not motivated) are considered, the question of "Is job enrichment truly a universal organization cure?" becomes an increasingly valid concern.

A question has also been raised as to the validity of job enrichment "successes" in terms of satisfaction or acquiescence. In measuring the satisfaction of a worker after job enrichment, is it possible that the measurement is actually one of acquiescence? In a particular study concerning automation conducted by Chadwick-Jones, it was hypothesized that job satisfaction was more a reflection of the workers' general acceptance of the change-over than of positive attitudes towards rewards of the job (Chadwick-Jones, 1969: 80).

Still more fundamentally, there have been questions concerning the basic tenets, "motivator" and "hygiene" factors, themselves (see, for example, Dunnette, Campbell, and Hakel, 1967; Hinton, 1968; King, 1970. For analyses favorable to the two-factor theory, see Herzberg, 1971; Whitsett and Winslow, 1967). It appears that the original splitting of factors into "motivational" and "hygiene" factors may have been merely a function of methodology, which renders the present conceptual status of the two-factor-theory

highly uncertain. Also, the two-factor-theory does not allow for the differences among people and the manner in which they respond to "enriched" jobs, as it appears some people are more likely to respond favorably to enriched, complex jobs than others (Hulin, 1971). Finally, the two-factor-theory does not presently identify a method of measuring the presence or absence of motivating factors in ongoing organizations. This makes a test of the theory or evaluation of the effects of work redesign more difficult (Hackman, 1976: 251-252).

In an article by Sirota and Wolfson the point is made that "(s)uch techniques as job enrichment . . . are adopted for the wrong reasons and applied to the wrong problems, thus perpetuating--and even aggravating--the conditions that management sets out to correct (Sirota, 1973: 120). The article goes on to say that even though there has been a great deal of enthusiasm and some well-published successes for job enrichment and other behavioral-science techniques, there continues to be a discouragingly high failure rate among corporate applications. The cause attributed to this high failure rate is the prescription of the wrong medication for the wrong disease. This occurs, according to Sirota and Wolfson, because:

1. Management becomes infatuated with particular behavioral-science techniques.

2. Management has erroneous preconceptions of employee's needs.

3. Management perceives surface manifestations properly, but fails to go deep enough into

the organization.

(Sirota, 1973: 120-128).

These brief examples of the possibilities of misapplying job enrichment or misinterpretting the results also serve as an introduction to the aspect of job enrichment applications which have been labled "Patsy." There are several reasons why job enrichment cannot be applied to some situations just as there are situations in which, although needed, job enrichment was applied incorrectly. The following are representative of the mistakes which can be or have been made.

One of the most obvious reasons not to apply job enrichment is the fact that not all jobs possess those elements which lend themselves to enrichment. Some jobs contain very basic or menial tasks which cannot be changed to provide increased commitment or motivation. In jobs of this type, it is necessary to concentrate on hygiene factors and at least to create an acceptable and non-dissatisfying job environment. Furthermore, some individuals are either incapable or unwilling to assume the responsibility to perform enriched jobs.

In the abstract of <u>Work, Productivity and Job Satisfaction</u>, Katzell states that: Limited programs such as job enrichment, by themselves are unlikely to create large or enduring improvements in productivity and job satisfaction. Job enrichment would better be regarded as a possible ingredient in redesigned socio-technical systems of work. Socio-technical systems with the following features seem to

improve both productivity and job satisfaction:

> 1. Financial compensation must be linked to performance.
> 2. Workers and work must be matched to create work situations which meet worker needs and expectations and so that workers will have capabilities and resources to be successful.
> 3. The work should provide the opportunity for full use of workers' abilities.
> 4. The workers at all levels must have inputs to decisions and plans affecting jobs and job environment.
> 5. The appropriate resources must be provided to facilitate performance and minimize obstacles in carrying out jobs.
> 6. Adequate hygiene factors must exist (supervision, pay, job security, working conditions, employee and labor relations).
>
> (Katzell, 1975: abstract).

While some may feel that the theories expounded in this study are far in advance of present-day needs, we should remember the popular attitude toward job enrichment when that theory was initially introduced. Even though it could be argued that cases in which Katzell's theory could be applied would be even more limited than orthodox job enrichment (two-factor-theory) it should be used in place of job enrichment in situations where the added detail would be more appropriate.

In their article, Chung and Ross expound the belief that a job enrichment program will not work unless it is used in conjunction with a job enlargement program. Chung and Ross state that, "Job enlargement requires changes in the technical aspects of a job, while job enrichment

requires changes in behavioral systems in an organization." If a job enrichment program is to be sucessful, all workers should be involved in goal-setting for their work groups. Furthermore, proponents of job enrichment specify that goal-setting should be applied at all levels of the organization. Chung and Ross, however, assert that this is not practical at lower levels as the employees may not be technically or psychologically prepared for this responsibility. To carry this idea one step further, Chung says, "Job enrichment may not be applicable to all employees" for the following reasons: Job enrichment "can have a strong motivational value for employees who prefer a challenge in performing demanding jobs; have abilities to perform, and are motivated to satisfy higher-order needs." Yet, job enrichment "may have little or even a negative effect on workers who prefer lower task difficulty, are unskilled, and are primarily motivated by lower-order needs." (Chung, 1977: 113-122). This study asserts that it is doubtful whether job enrichment alone has a strong motivational impact, yet according to Chung, a job enrichment program seemed to gain motivational power when combined with job enlargement. In this case, it was shown that, although job enrichment may be applied correctly, it happened that it was not enough and was more "proper" when combined with another principle, job enlargement.

In their article, Parke and Tausky closely examine the merits of self-actualization as opposed to job enrichment.

(Parke, 1975: 12-21). Their main criticism lies in the assumption made by Herzberg and others that more interesting and challenging work provides incentive for workers to improve performance on the job. The usual explanation for this correlation between job enrichment programs and increased performance is that, once jobs have been enriched, job satisfaction increases and workers apply themselves more diligently in response. It seems more plausible to argue that the presence of employee behavior desired by management stems from holding the worker accountable for his actions and rewarding the performance which meets expected standards. Using this theory, work motivation would involve an assessment of the chances of obtaining various rewards. With this in mind, managers who question the productivity of their workers should compare the rewards given to good performers to those given to poor performers.

Turning to actual cases of job enrichment application, Parke and Tausky offer alternate explanations for the proclaimed successes of job enrichment programs. In the case of Robert N. Ford's oft-cited study in the Bell System, Parke and Tausky point out two examples of eliciting appropriate behavior by inducements:

1. In the first example (involving the directory compiling function), by reducing the number of individuals handling each entry, the potential for buck-passing was severely restricted.
2. In the example of the service representative, the responsibility for delay was fixed to specific individuals.

In both of the above cases, "the impact of the shift from

delays of anonomous origin to delays directly traceable to an individual should not be overlooked." (Parke,1975: 18). With the case of Texas Instrument, "(d)issatisfaction with the performance of outside janitorial contractors led Texas Instrument to bring the janitorial function under company control and at the same time enrich the janitorial jobs." Success was, ". . .attributed to the fact that employees had gained a voice in planning, freedom to develop their own cleaning strategies, thorough training and the availability of adequate equipment." (Ibid: 19). It should be noted that not only did the janitors' pay and benefits increase substantially, but that the company was also inspecting the areas weekly. Finally, in the case of Motorola's Page-Boy II assembly line on which workers assembled whole units and signed their names, the question was raised whether job enrichment really affected productivity. This question was linked to the fact that, "the heightened accountability of each assembler for his output stands in stark contrast to the anonymity enjoyed by his counterparts on the assembly-line." (Ibid: 19). In light of these cases, Parke and Tausky conclude that job enrichment can work--if it is designed to include control mechanisms for accountability and rewards for output beyond standards.

SUMMARY

In summary, J. Richard Hackman asserts that, ". . .job enrichment can improve work systems and that the theory is

perfectly sound. What is wrong. . .is the way most projects are implemented." (Hackman, 1975: 129). According to Hackman, common errors in implementation include:

1. Rarely are the problems in the work systems diagnosed before the jobs are redesigned.

2. Sometimes the work itself is not changed.

3. Even when the work itself is substantially changed, anticipated gains are sometimes diminished or reversed because of unexpected effects on the surrounding work system.

4. Rarely are the work redesign projects systematically evaluated. Why?
   a. There is no way to translate the human gains into dollar figures that people can agree upon.
   b. It is difficult to determine what proportions of measured productivity and unit profitability are attributable to job redesign.
   c. Many accounting systems are not designed to handle the costs of absenteeism, turnover, training and extra supervisory time.
   d. Many managers do not trust the job satisfaction measures to which they do have access.

5. Line managers, consulting staff members, and union officers do not obtain appropriate education in the theory, strategy and tactics of work redesign.

6. Traditional bureaucratic practice creeps into work design activities. Expecting to achieve a flexible, employee-oriented work system with rigid, bureaucratic procedures that operate strictly from the top down is unrealistic.
   (Ibid: 130-137).

CONCLUSIONS

If any conclusion can be drawn from this diversity among noted experts, it would be that there is no right answer, no approved solution to the question of job

enrichment. There are proper and improper ways to prescribe job enrichment when the diagnosis is correct. The background material seems to demonstrate that, when the diagnosis is not correct, the cure can be worse than the malady. Job enrichment does not compensate for incompetence, nor will it unseat deeply ingrained fear or dislike of responsibility. Job enrichment is but one of the many tools available to supervisors--it is not a panacea for all behavioral problems. Nor is it a patsy when applied correctly.

To quote Father Peter, ". . .What is not so harmless is the belief that job enrichment is <u>the</u> answer. It is only a first step." (Drucker, 1974: 276).

CHAPTER 3
METHODOLOGY

BACKGROUND

As mentioned earlier, this thesis is designed to aid in the evaluation of the effectiveness of job enrichment programs being implemented throughout the Air Force Logistics Command. Specifically, it is hoped that the methods developed for this research effort will be beneficial in evaluating the effectiveness of the job enrichment program now being implemented at Newark AFS.

The production data necessary for the estimation of the production functions were obtained and summarized from a Headquarters, Air Force Logistics Command standard printout. This report, "Productivity Index Computation, Director of Maintenance, Aerospace Guidance and Metrology Center, Newark AFS, Ohio," is from the Productivity Measurement Organic Cost Detail. Similar printouts are available for all Air Force Logistics Command repair depots.

After formulating a very generalized approach to this study of job satisfaction it was necessary to construct a questionnaire which would measure job satisfaction and to administer this questionnaire at Newark AFS. The questionnaire used to gauge these attitudes was the result of much research and several revisions. The management and union officials at Newark AFS were consulted during the formulation process. In accordance with directives, the questionnaire was forwarded to Labor and Employee Relations Division,

Directorate of Civilian Personnel, Headquarters United States Air Force (USAF) in order to have a survey control number assigned. This control number is, in effect, an official release by Headquarters, USAF which allows the questionnaire to be administered to, in this case, Civil Service employees of the Air Force (see Appendix B).

The details as to the date, location, and procedures for testing were arranged in four separate sessions. Initially, the feasibility of conducting a study and of administering an assessment was discussed with the Productivity Enhancement Office at Newark AFS, which had been responsible for earlier measurement tests conducted at Newark. Secondly, a meeting was held with the Directorate of Maintenance in order to familiarize him with the thesis study and the expected results. At this time, the decision was made to administer the questionniare at the beginning and end of shifts, so as to disrupt normal work flow as little as possible. It was also agreed that the questionnaire would be administered in central testing areas and in individual break areas. Additionally, the Directorate of Maintenance offered to review the questionnaire at a staff meeting and to lend his support in an effort to encourage volunteers to participate in the testing. The third step involved a meeting with the President of the American Federation of Government Employees (AFGE), Local 2221. At this time, the president was informed of the purpose of the questionnaire and official union approval was sought and

obtained. Finally, further meetings were held with the Productivity Enhancement Office in order to finalize testing times and locations. As planned, the questionnaire was administered in an available conference room and in break areas over a three-day period with the assistance of the Productivity Enhancement Office.

SCOPE OF DATA

The twenty (20) end items for which the production data were obtained represent approximately ninety percent of the costs incurred by the Newark AFS depot Maintenance Industrial Fund (DMIF). Hence, these items and their respective work centers are regarded as being representative of the overall production of Newark AFS. The data used for this research effort included: end items (UNITS), which were the number of actual units repaired per quarter; direct labor hours (DIRLHR), which were the actual direct labor hours recorded to produce the end items; and direct material costs (DIRMAT), which were the costs for the material necessary to produce the end items. Quarterly wholesale price indeces were calculated by averaging monthly indices over three-month periods. These quarterly wholesale price indices were then divided into corresponding quarterly production data. This converts the "material input" into real terms (i.e. 1967 dollars), a transformation necessary for estimating a production function.

It should be noted that, due to the implementation of

a computer-based system for recording material inventories, there is some additional noise in the production data for the calendar year 1975. This noise was caused by a failure of the system to process the data properly. From one to twenty percent of the observations were pulled from this time period, depending upon the line item involved. It is not clear at this time what type of biases this induced in the estimating equations.

When available, production data from July, 1972 through September, 1976 were used. For nine of the end items, the full set of observations was obtained. The other eleven cases required appropriate adjustments to accomodate shorter periods.

DESCRIPTION OF END ITEMS

Table I describes the various end items used in the production data, the weapons systems on which they are used, and the end items. The twenty items are repaired in fourteen isolated work stations. In some cases, individuals had been assigned to work on several similar items over a period of time. In these instances, the results of the questionnaires were matched to the production data for each of the end items on which these individuals had worked in an attempt to identify the workers' degree of satisfaction or dissatisfaction with all of the appropriate production data.

CONDESCRIPTIVE TECHNIQUE

The condescriptive analysis used in this thesis comes from the Statistical Package for the Social Sciences, (SPSS)

TABLE I

End Item	Weapons System	Description
LN12	F-4	Navigation Set
LN14	F-111 A/E	Navigation Set
LN15	B-52 G/H	Navigation Set
VM8	F-111	Velocity Meter
G200	F-4	Gyroscope
T38	T-38	Displacement Gyroscope
TITAN	Titan	Missile Guidance System
D7900	C-5A	Navigation Set
SR3	FB-111	Displacement Gyroscope
AB2171	F-4C, F-105, AC-119	Displacement Gyroscope
W2171	F-105, F-106	Displacement Gyroscope
KT73	A-7D, AC-130H	Inertial Measurement Unit
NS20	Minute Man III	Missile Guidance Set
NS17	Minute Man II	Missile Guidance Set
KT71	F-105 D	Inertial Measurement Unit
N16	F-111 (Navy)	Inertial Reference Unit
G9	F-111 (Navy)	Gyroscope
C5A	C-5A	Inertial Guidance System
N10	Minute Man I	Missile Guidance Set
KT76	SRAM	Navigation Set

using the computer facilities at the Air Force Institute of Technology (AFIT). Primarily, the mean values for the questionnaire responses and production data variables (see Appendix A) were calculated to measure the central tendancy of the variable values. This technique uses the sum of the individual values for each case divided by the total number of cases

$$\overline{X} = \frac{\Sigma_{i=1}^{N} X_i}{N}$$

where X_i represents the value of each case and N represents the total number of valid cases (Nie, 1975: 183).

The condescriptive analysis was used to determine the mean value of responses for each question on the questionnaire. It was also used to determine mean values for the production data to be used in the final analysis.

MULTIPLE REGRESSION

In this thesis, multiple regression, a general statistical technique, was used to analyze the relationship between the dependent variable, end item, and the independent variables, direct labor hours and direct material costs. A simple linear regression was used to analyze the relationship between the dependent variable, job satisfaction questionnaire response means, and the independent variables computed from production data regression coefficients. The purpose of using these regression techniques was ultimately to

determine if there was any type of relationship between a computed measure of productivity (dependent variable) and some measure of job satisfaction (independent variables).

These various regression techniques were used to estimate suitable production functions which would accurately describe the repair process at Newark AFS, from which marginal products could be derived. These production functions are of the general form

$$Y = f(L,K)$$

where Y (dependent variable) represents end items and L and K (independent variables) represent direct labor hours and direct material costs respectively. For reasons that will be discussed, the only marginal product used in this thesis was that of direct labor, which is arrived at by taking the partial derivative of Y with respect to labor which gives

$$\frac{\partial Y}{\partial L} = f_L$$

In effect, the test used in the final analysis portion of this thesis becomes

$$H_o: \quad \frac{\partial f_L}{\partial JS} > 0$$

which simply is asking the question, "Is the partial of the marginal product of labor with respect to some measure of job satisfaction a positive value?"

For the initial analysis (where the production functions were being tested), three different regressions were run: a simple linear relationship; a generalized Cobb-Douglas (C-D) production function; and a derivative of the generalized Cobb-Douglas production function which simply adds the product of logs of the two independent variables (direct labor hours and direct material costs), which, hereafter, will be referred to as the Variable Elasticity of Substitution (VES) production function (Vinod, 1972: 531-543).

With these initial regression forms, the independent variables describing direct labor (L) were forced to enter the regression first; primarily because direct labor hours more accurately described the change in units produced, according to personnel in the Productivity Enhancement Office at Newark AFS. In all the initial regressions, the dependent variable (Y) represents the values for units produced. It should be noted that the information pertaining to the independent variables, direct material (K) and the variable created for the VES regression (LK) are also included in the analysis in order to illustrate the change in the dependent variable with respect to changes in the two independent variables, K and LK.

In all the regressions used for this thesis, the values of the dependent variables are predicted from a generalized linear function in the form

$$Y' = \alpha + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_i X_i$$

where Y' is the estimated value of the dependent variable Y. α and β_i in this formula are constants which are usually referred to as regression coefficients. They define the slope of the regression line indicating the expected change in Y with a change of one unit in X. The constant α is the Y axis intercept which is the predicted value of Y when X equals 0. In more detail, to quote from SPSS:

> The difference between the actual and the estimated value of Y for each case is called the residual, i.e., the error in prediction, and may be represented by the expression
>
> $$\text{Residuals} = Y - Y'$$
>
> The regression strategy involves the selection of α and β_i in such a way that the sum of the squared residuals is smaller than any possible alternative values.
>
> The predicted Y' values fall along the regression line, and the vertical distances (Y - Y') of the points from the line represent residuals (or errors in prediction). Since the sum of squared residuals is minimized, the regression line is called the <u>least-squares line</u>, or <u>the line of best fit</u>. In other words, there is no other line which is 'closer' to the points i.e., for no other line is $\Sigma(Y\ Y')^2$ smaller. (Nie, 1975: 323).

With the three regressions used, the program (from SPSS) calculated and printed the following: (1) R^2 values; (2) regression coefficients; (3) F-statistics with significance levels; (4) a correlation table; and (5) the Durbin-Watson statistic.

The Durbin-Watson Test against autocorrelation uses the null hypothesis which states that the residual sums of squares are independent. "The null hypothesis is rejected in favor of the alternative hypothesis that the disturbances are positively autocorrelated when (the Durbin-Watson

statistic) takes a sufficiently small value." (Theil, 1971: 199-200). In cases where the Durbin-Watson statistic is "too small," an autoregressive transformation is made. Theil says that in this transformation, "the values taken by each variable are replaced by a linear combination of successive values." (Ibid: 253-354). This transformation procedure is clearly illustrated in the following chapter.

LINEAR REGRESSION (Initial Analysis)

When the linear regression form is used, the equation is

$$Y = \alpha + \beta_1 L + \beta_2 K + u$$

(where σ is equal to infinity)

NOTE: In all regression forms used in this thesis, u represents the errors in prediction or residuals and Y is the dependent variable. In order to standardize all regression forms used, α represents the Y intercept and β_1, β_2 are regression coefficients. σ is the elasticity of substitution of the variables L and K.

Because this formula is in the form necessary to use with the SPSS regression program, no transformations are necessary and the data is used in this form by the computer.

The marginal product for this case is found by taking the partial of Y with respect to L which gives

$$\frac{\partial Y}{\partial L} = \hat{\beta}_1$$

Since $\frac{\partial Y}{\partial L}$ could be influenced by the magnitude of the variables involved it was necessary to transform $\frac{\partial Y}{\partial L}$ to the form of an elasticity of Y with respect to L by multiplying

both sides by $\frac{L}{Y}$ to give

$$\frac{EY}{EL} = \hat{\beta}_1 \frac{L}{Y}$$

The elasticity of Y with respect to L varies with the amount of labor used. The standard error of $\frac{EY}{EL}$ is at a minimum when L and Y are evaluated at the sample means. Hence, the following form was used:

$$\frac{EY}{EL} = \hat{\beta} \frac{\bar{L}}{\bar{Y}}$$

(where $\bar{L}$ and $\bar{Y}$ are mean values of L and Y.)

<u>COBB-DOUGLAS</u> (Initial Analysis)

The Cobb-Douglas regression used in this study originates from the Cobb-Douglas production function:

$$Y = \alpha L^{\beta_1} K^{\beta_2} e^u$$

(where e^u has a log normal distribution and σ is equal to one.)

Through the use of logarithms, this is transformed to

$$\ln Y = \ln\alpha + \beta_1 \ln L + \beta_2 \ln K + u$$

by renaming the variable, this becomes

$$Y^* = \alpha^* + \beta_1 L^* + \beta_2 K^* + u$$

*indicates natural logarithm

which is in the proper form to be used with the SPSS regression program.

The marginal product for the Cobb-Douglas production function is arrived at by beginning with the generalized production function

$$Y = \alpha L^{\beta_1} K^{\beta_2}$$

taking partials of both sides

$$\frac{\partial Y}{\partial L} = \beta_1 \alpha L^{\beta_1 - 1} K^{\beta_2}$$

then, through multiplying both sides by $\frac{L}{Y}$ to put it in the form of an elasticity, grouping of terms, and cancellation, this becomes

$$\frac{EY}{EL} = \hat{\beta}_1$$

Unlike the linear case, the elasticity of Y with respect to L is a constant.

VES (Initial Analysis)

The third regression used in this study comes from the nonhomogeneous production function

$$Y = e^{\alpha} L^{\beta_1 + \beta_3 \ln K} K^{\beta_2}$$

(where σ is greater than zero and less than infinity.)

which is linear in its parameters and can be estimated using the SPSS regression routine. This can be written as

$$\ln Y = \alpha + \beta_1 \ln L + \beta_2 \ln K + B_3 \ln L \ln K + u$$

For use with the SPSS regression program, this can be written as

$$Y^* = \alpha + \beta_1 L^* + \beta_2 K^* + \beta_3 L^* K^* + u$$

*indicates natural logarithm

For a more detailed derivation, see the autumn, 1972, <u>Bell Journal of Economics and Management Science</u>, pages 531-543. The derivation of the marginal product for VES regression begins with

$$Y = e^{\alpha} L^{\beta_1 + \beta_3 \ln K} K^{\beta_2}$$

taking the natural logarithm of both sides

$$\ln Y = \alpha + \beta_1 \ln L + \beta_2 \ln K + \beta_3 \ln L \ln K$$

and putting it into the form of an elasticity yields

$$\frac{EY}{EL} = (\hat{\beta}_1 + \hat{\beta}_3(\overline{\ln K}))$$

(($\overline{\ln K}$) is defined as the mean value of the natural logarithm of direct material costs.)

FINAL ANALYSIS

The final stage of the analysis for this thesis involved the grouping of selected responses from the questionnaire, determining mean values for those groupings and using the mean values in linear regressions with measures of $\frac{EY}{EL}$ by product line (20 line items) and over the three (3) different forms. This section will describe in detail the procedures and the rationale involved in this final analysis.

With the questionnaire results, the following groupings were made:

> Responses to questions seven, eight, and twenty-four were combined to form the variable SAT 1.
>
> Responses to questions eleven through nineteen were combined to form the variable SAT 2.
>
> Responses to questions twenty, twenty-one, and twenty-two were combined to form the variable SAT 3.

This grouping was done in a way which still allowed the responses to be identified with the associated line items.

Questions seven, eight, and twenty-four were combined as it was felt that, collectively, they represented a good overall measure of an individual's satisfaction. Responses for questions seven and eight (see Appendix C) were converted to numerical values in the following manner: a=1, b=2, c=3, d=4, e=5, f=6, g=7. In effect, those questions were converted to a Likert Scale in which one represented Highly Dissatisfied. Because questions seven, eight, and twenty-four were added together, the possible values for the SAT 1 variable ranged from three (Highly Dissatisfied) to twenty-one (Highly Satisfied), with twelve being the midpoint or point of neutrality.

The variable SAT 2 was formed by combining the results from the responses to questions eleven through nineteen (see Appendix C). The rationale for this combination is based primarily on studies by Dr. Herzberg in which he lists the following as ingredients of a good job: 1) feedback; 2) client relationship; 3) continued learning; 4) ability

to schedule own work; 5) personal accountability; 6) personal expertise; 7) control of own resources; 8) direct communication (see: Herzberg, 1971: 95; Herzberg, 1968: 57; Herzberg, 1975: 43-44; Herzberg, 1974: 72-74; and two summaries from the Hill AFB Orthodox Job Enrichment Program, dated 14 April, 1975 and 21 April, 1976). Dr. Herzberg identified these factors as being ingredients of a good job in his article "The Wise Old Turk" (Herzberg, 1974: 71) in which he said, ". . .(these) motivator factors are a direct derivation of the connection I have observed between the quality of motivation and hygiene and the quality of job performance." These factors are not employed in this thesis in order to test Dr. Herzberg's theory, but to determine whether there is any measurable correlation between them and job satisfaction. The aforementioned ingredients of good jobs were identified with the questionnaire responses as listed in Table II. Because questions eleven and twelve both dealt with feedback, those responses were divided by two and added together. The resulting sum was then added to the responses for questions thirteen through nineteen. In this way, Highly Dissatisfied would be represented by eight, while fifty-six would signify Highly Satisfied. Neutrality would then be at thirty-two.

The variable SAT 3 was a combination of questions twenty, twenty-one, and twenty-two and was primarily an attempt to determine whether the combination of those variables could be employed as some sort of measure of job

TABLE II

Ingredient	Questionnaire response
Feedback	11 and 12
Client relationship	13
Continued learning	14
Schedule own work	15
Personal accountability	16
Personal expertise	17
Control of own resources	18
Direct communication	19

satisfaction. As with SAT 1, the range of possible values for this variable ranged from three to twenty-one, the midpoint being twelve.

After the questionnaire responses were transformed into the variables SAT 1, SAT 2, and SAT 3 and mean values were determined (using the Condescriptive program of SPSS), they were used as independent variables in the simple linear regression for the final analysis. The marginal products determined earlier for each regression form were used as the dependent variable in this regression. The results of this regression were used to determine whether there is any relationship between productivity and job satisfaction.

SUMMARY

Thus, the linear regression, Cobb-Douglas regression, and VES regression were used to analyze production data while condescriptive methods were used to analyze the data gathered in the questionnaire. The final analysis combined grouped questionnaire responses (independent variables) with production function marginal products (dependent variables) into a linear regression. The results of this regression were used to determine whether there is a relationship between productivity and job satisfaction.

CHAPTER 4
DATA ANALYSIS

INTRODUCTION

In this chapter, the data collected from the job satisfaction questionnaire and from production figures will be applied and the results of the regressions will be analyzed in order to determine whether there is any relationship between variations in job satisfaction and productivity. The methods used are condescriptive analysis, multiple regression analysis, and, finally, a simple regression using results from the previous analyses.

BACKGROUND MATERIAL

In order to become familiar with the techniques of condescriptive and regression analyses, a test program was run using data from a previous thesis (Clark, 1975). which also employed production data from Newark AFS. In this experimental run, a variety of regression forms were tested. Linear, Cobb-Douglas, nonlinear, polynomial, VES, and orthogonal polynomial regressions were all run. At this time, the research was limited to three forms which seemed to be workable within the limitations of this thesis. Linear, Cobb-Douglas, and VES regressions were found to be the most suitable.

ASSESSMENT

After the questionnaires were administered, the answers were transferred to IBM cards and then placed on disk for

analysis. Using the condescriptive program from SPSS, the mean values, variance, and minimum and maximum values were calculated for responses by line item and by individual questions. These values were also calculated by line item for the entire questionnaire (see Appendix D). The individual responses were used to calculate mean values, variance, and minimum and maximum values for the variables SAT 1, SAT 2, and SAT 3 by line item (see Appendix E). The reader is reminded that the possible range of answers for the individual questions and the questionnaire as a whole was one to seven, with four being the neutral point. The range of individual response means are located in Table III, as is the range of responses for the entire sample. As an example, using the mean responses for questions seven through twenty-five for line item LN12 (see Appendix D), the high mean value, in this case, is associated with question eight (value = 4.814) while the low mean value is associated with question twenty-five (value = 2.288). The range of possible values for the variables SAT 1, SAT 2, and SAT 3 varied. The mean values for these variables can be found in Table IV.

PRODUCTION DATA

Both condescriptive and regression analyses were used with the production data. The raw production data used for this thesis can be found in Appendix F. The condescriptive program was used to determine mean values for this data.

TABLE III

End Item	Low Mean Value	High Mean Value
LN12	2.288	4.814
LN14	2.200	5.000
LN15	2.438	5.000
VM8	2.000	4.500
G200	2.179	4.750
T38	2.000	5.000
TITAN	1.889	4.756
D7900	1.833	5.500
SR3	1.200	4.600
AB2171	2.483	5.138
W2171	1.941	5.529
KT73	1.250	5.125
NS20	2.586	5.138
NS17	2.357	5.286
KT71	2.625	5.125
N16	1.125	5.250
G9	2.333	5.500
C5A	2.333	4.917
N10	2.833	5.333
KT76	1.800	5.400
All line Items	2.344	4.828

Note: Possible range of responses 1 to 7, with 4 neutral.

TABLE IV

End Item	SAT 1 * Mean Values	SAT 2 ** Mean Values	SAT 3 * Mean Values
LN12	13.966	28.441	11.847
LN14	14.300	26.417	11.600
LN15	14.563	28.219	13.125
VM8	12.333	25.250	9.667
G200	14.107	27.893	11.429
T38	13.429	29.957	12.000
TITAN	14.000	28.244	12.511
D7900	15.000	33.500	14.167
SR3	13.000	23.200	10.600
AB2171	14.690	31.345	13.483
W2171	15.412	31.853	14.765
KT73	14.250	27.250	12.875
NS20	14.862	31.483	12.931
NS17	14.548	29.988	12.071
KT71	14.625	33.000	12.250
N16	13.875	24.000	9.250
G9	15.500	31.667	12.500
C5A	13.917	26.125	11.000
N10	14.917	31.542	14.083
KT76	14.800	31.200	12.800

*Range of possible values 3 to 21, with 12 neutral.
**Range of possible values 8 to 56, with 32 neutral.

These mean values were used in the final analysis.

With the initial linear regressions, the dependent variable Y was composed of the values of UNITSP (see Appendix A for explanation of variable notation). The independent variables L and K represent DIRLHR and DIRMAT, respectively (see Appendix F). The R^2 values using DIRLHR alone ranged from 0.83565 to 0.01395. The F-statistic/significance values ranged from 30.506451/0.001 to 0.21227/0.652, with the Durbin-Watson test values ranging from 2.49172 to 0.42410, indicating positive autocorrelation in the error terms in seven cases. After applying the autoregressive transformation (see Appendix H) the variables for the regression became UNITSF, DIRLHF, and DIRMAF, respectively. The R^2 values using DIRLHF alone ranged from 0.91296 to 0.00001. The F-statistic/significance values ranged from 94.402763/0.000 to 0.000013/0.997, with Durbin-Watson test values ranging from 2.90939 to 0.97745. For an example of the information available with the linear regression procedure, see Tables V and VI. For a complete analysis of all twenty line items, see Appendix G (with autocorrelation) and Appendix J (after autoregressive transformation). Both the correlation tables and the reduction in the partial F-statistics (after bringing K into the regression) confirmed the presence of collinearity between L and K. Hence, K was omitted from the regression in the final analysis (see Appendix G), as it was not possible to analyze the partial effects of L and K. The regression equation to be analyzed

in the final analysis using the direct labor hour regression coefficient from the linear regression thus became

$$Y_1 = \alpha + \beta X_1 + u$$

where

$$\frac{EY}{EL} = \frac{\hat{\beta}_1 \bar{L}}{\bar{Y}_1}$$

For the Cobb-Douglas regression, it was first necessary to find the natural logarithms of the variables UNITSP, DIRLHR, and DIRMAT (from Appendix F) which thus became UNITSL, DIRLHL, and DIRMAL, respectively. With the Cobb-Douglas regressions, the dependent variable Y was composed of the values of UNITSL, and the independent variables L and K represent DIRLHL and DIRMAL, respectively. The R^2 values using DIRLHL alone ranged from 0.81556 to 0.00009. The F-statistic/significance values ranged from 22.38436/0.000 to 0.00097/0.976, with Durbin Watson test values ranging from 2.69436 to 0.84796, indicating positive autocorrelation in the error terms in five cases. After applying the autoregressive transformation the variables for the regression became UNITSFL, DIRLHFL, and DIRMAFL, respectively. The R^2 values using DIRLHFL alone ranged from 0.81556 to 0.00688. The F-statistic/significance values ranged from 19.33396/0.001 to 0.10390/0.752, with Durbin-Watson test values ranging from 2.81650 to 0.90603. For an example of the information available with the Cobb-Douglas regression

procedure, see Tables V and VI. For a complete analysis of all twenty line items, see Appendix G (with autocorrelation), and Appendix J (after autoregressive transformation). Once again, the correlation tables and changes in the partial F-statistic values (after bringing K into the regression) confirmed the presence of collinearity between L and K. Hence, K was omitted from the regression in the final analysis (see Appendix G), as it was not possible to analyze the partial effects of L and K. The regression equation used in the final estimation equation thus became

$$\ln Y_2 = \alpha + \beta_1 \ln L + u$$

where

$$\frac{EY}{EL} = \hat{\beta}_1$$

For the VES regression, the variables UNITSL/UNITSFL, DIRLHL/DIRLHFL, and DIRMAL/DIRMAFL were used from the Cobb-Douglas regression analysis along with the variable DIRLML/DIRLMLF which was computed from DIRLHL multiplied by DIRMAL for DIRLML and DIRLHFL multiplied by DIRMAFL in the case of DIRLMLF. With the VES regressions, the dependent variable Y was composed of the values of UNITSL, and the independent variables L, K, and LK represent DIRLHL, DIRMAL, and DIRLML, respectively. The ranges of the R^2 values were the same as with the Cobb-Douglas regression. The F-statistic/significance values for DIRLHL ranged from 9.62171/0.008 to 0.00011/0.992. The Durbin-Watson test values ranged from

TABLE V					
LN14	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.59648	0.48526	0.77380	0.56554	0.75740
DIRLHR/L**		0.66420		0.66619	0.96591
DIRMAT/L***					0.83535
REGRESSIONS LINEAR					
DW 1.48641					
R^2	0.35578	0.36998			
α^a	64.69834	0.00024			
F	146.96000	2.98901			
Sign	-0-	0.106			
β	0.00029	0.00063			
F	8.28411	0.31552			
Sign	0.011	0.583			
COBB-DOUGLAS					
DW 1.76227					
R^2			0.59876	0.60327	
α^a			2.73446	0.14336	
F			66.33791	10.00162	
Sign			-0-	0.007	
β			0.15540	0.04165	
F			22.38436	0.15889	
Sign			-0-	0.696	
VES					
DW 2.06229					
R^2			0.59876	0.60327	0.66698
α^a			2.73446	0.14336	1.43593
F			66.33791	10.00162	3.06082
Sign			-0-	0.007	0.104
β			0.15540	0.04165	-0.14245
F			22.38436	0.15889	2.48700
Sign			-0-	0.696	0.139

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a]When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

TABLE VI					
LN14	DIRLHF	DIRMAF	DIRLHFL	DIRMAFL	DIRLMLF
CORRELATION					
UNITSF/L *	0.72685	0.64051	0.52057	0.49277	0.63258
DIRLHF/L**		0.71148	0.85442	0.47491	0.78882
DIRMAF/L***			0.45250	0.80627	0.82081
REGRESSIONS					
LINEAR					
DW 2.90939					
R^2	0.52830	0.55913			
α^a	2.82123	0.00213			
F	0.45646	4.38988			
Sign	0.510	0.056			
β	0.00282	0.00009			
F	15.68012	0.90887			
Sign	0.001	0.358			
COBB-DOUGLAS					
DW 2.72518					
R^2			0.14346	0.15879	
α^a			-2.11802	0.44521	
F			0.63893	1.44388	
Sign			0.437	0.251	
β			0.51219	0.10480	
F			2.34490	9.23679	
Sign			0.148	0.635	
VES					
DW 2.66025					
R^2			0.14346	0.15879	0.17779
α^a			-2.11802	0.44521	-0.53865
F			0.63893	1.44388	0.07982
Sign			0.437	0.251	0.782
β			0.51219	0.10480	0.10207
F			2.34490	0.23679	0.27738
Sign			0.148	0.635	0.608

* UNITSL used with DIRLHFL, DIRMAFL, and DIRLMLF

** DIRLHFL used with DIRMAFL and DIRLMLF

*** DIRMAFL used with DIRLMLF

a. When DIRMAF, DIRMAFL, and DIRLMLF enter the regression, α, related F, and Sign values represent change in DIRLHF/L.

2.13009 to 0.81776, indicating positive autocorrelation in the error terms in eight cases. After applying the autoregressive transformation, the variables for the regression became UNITSFL, DIRLHFL, DIRMAFL, and DIRLMLF, respectively. The R^2 values using DIRLHFL alone ranged from 0.56311 to 0.00688. The F-statistic/significance values ranged from 9.62171/0.008 to 0.000/1.000. The Durbin-Watson test values ranged from 3.06669 to 0.84168. For an example of the information available with the VES regression procedure, see Tables V and VI. For a complete analysis of all twenty line items, see Appendix G (with autocorrelation) and Appendix J (after autoregressive transformation). As with the two previous regression forms, both the correlation tables and changes in F-statistic values (after bringing K and LK into the regression) confirmed correlation of L, K, and LK. No attempt was made, however, to correct collinearity in the case of the VES production function. The equation used was

$$\ln Y_3 = \alpha + \beta_1 \ln L + \beta_2 \ln K + \beta_3 \ln L \ln K$$

where

$$\frac{EY_3}{EL} = (\hat{\beta}_1 + \hat{\beta}_3(\overline{\ln K}))$$

(($\overline{\ln K}$) is defined as the mean value of the natural logarithm of direct material costs.)

FINAL ANALYSIS

The final analysis was composed of three simple linear regressions of the general form

$$\left[\frac{EY}{EL}\right]_j = \alpha + \beta(JS)_i + u$$

where $i = 1, 2, 3.$
$j = 1, 2, 3.$

The dependent variable $\left[\frac{EY}{EL}\right]_j$ is our measure of labor productivity. The independent variable $(JS)_i$ is one of our measures of job satisfaction. Specifically, for the three initial regression analyses

$$(1) \quad \text{linear:} \quad \left[\frac{\hat{\beta}_1 \bar{L}}{\bar{Y}}\right] = \alpha + \beta(JS)_i + u$$

$$(2) \quad \text{Cobb-Douglas:} \quad \hat{\beta}_1 = \alpha + \beta(JS)_i + u$$

$$(3) \quad \text{VES:} \quad \left[\hat{\beta}_1 + \hat{\beta}_3(\overline{\ln K})\right] = \alpha + \beta(JS)_i + u$$

The dependent variables using the three previous production functions are depicted as MEANLY, MEANLLY, AND MEANLLLY, respectively. The mean values of the questionnaire variables (SAT 1, SAT 2, and SAT 3--our measure of JS) were used as independent variables in each regression, for a total of nine regressions. The results for the nine regressions are contained in Table VII. The Durbin-Watson test in all nine regressions ($d_U = 1.41$) showed the absence of positive autocorrelation, making the autoregressive transformation

unnecessary (see Table VII).

The first of the final analysis regressions used as the dependent variable the values of (MEANLY) and the mean values from the job satisfaction questionnaire sets SAT 1, SAT 2, and SAT 3 as the independent variable $(JS)_i$.

$$\left[\frac{\hat{\beta}_1 \bar{L}}{\bar{Y}}\right] = \alpha + \beta(JS)_i + u$$

The hypothesis to be tested by all nine regressions for the final analysis may be stated as follows:

$$H_o: \beta = 0$$
$$H_a: \beta \neq 0$$

the test being

reject H_o if F_o is greater than F_{α, v_1, v_2}.

That is to say, this thesis is testing the null hypothesis that some measure of job satisfaction <u>is</u> <u>not</u> related to a measure of productivity against the alternate hypothesis that job satisfaction <u>is</u> related to productivity. In the final analysis, the F-test is used, using five percent points for the Distribution of F, with one and eighteen (n=20) degrees of freedom. Since, in all cases, an $F_{.05, 1, 18}$ is used, the value used for F_α is 4.41, rejecting H_o if F_o is greater and accepting H_o in the cases in which F_o is less than 4.41 (Theil, 1971: 720). It should be noted that, in this case, if the null hypothesis is rejected, the alternate hypothesis will be accepted. It is

TABLE VII

	SAT 1	SAT 2	SAT 3
CORRELATION			
MEANLY	- 0.60424	- 0.29980	- 0.42299
MEANLLY	0.26912	0.04165	0.36152
MEANLLLY	0.23264	0.29049	0.35498
REGRESSIONS			
MEANLY (Linear)			
DW	2.32241	2.31420	2.14184
R^2	0.36511	0.08988	0.17892
β	-42.92724	- 5.42427	-16.39768
F	10.35118	1.77768	3.92229
Sign	0.005	0.199	0.063
α	627.77818	171.42039	214.55077
F	10.78878	2.07878	4.42002
Sign	0.004	0.167	0.050
MEANLLY (Cobb-Douglas)			
DW	1.52642	1.50244	1.76958
R^2	0.07243	0.00174	0.13070
β	0.15373	0.00605	0.11268
F	1.40550	0.03128	2.70624
Sign	0.251	0.862	0.117
α	- 2.01921	0.00357	- 1.20030
F	1.18173	0.00001	2.02115
Sign	0.291	0.997	0.172
MEANLLLY (VES)			
DW	2.26501	2.24343	2.20825
R^2	0.05412	0.08438	0.12601
β	0.55853	0.17761	0.46505
F	1.02991	1.65890	2.59521
Sign	0.324	0.214	0.125
α	- 7.46395	- 4.63823	- 5.17016
F	0.89637	1.32462	2.11142
Sign	0.356	0.265	0.163

interesting to note (from Table VII) that the F-statistic values for SAT 1, SAT 2, and SAT 3 were 10.351185, 1.7776762, and 3.9222898, respectively. The test involving SAT 1 (a generalized job satisfaction measure) was the only one to reject the null hypothesis, while the variable SAT 2 (developed to capture Dr. Herzberg's ingredients of a good job) failed to reject the null hypothesis. While the R^2 values were expected to be low, since many variables may affect worker productivity, it is interesting to note that the R^2 value for SAT 2 (0.08988) was the lowest. It should also be noted that all three β values (especially in the case of SAT 1, which rejected the null hypothesis) were negative, suggesting a negative relationship (albeit of a low significance value) between productivity and job satisfaction for this measurement.

With the Cobb-Douglas related data (MEANLLY), the dependent variable for the three simple regressions was simply the values of the direct labor hour regression coefficient. The independent variable $(JS)_i$ was again the mean values of SAT 1, SAT 2, and SAT 3 for the three regressions, respectively. The equation being

$$\hat{\beta}_1 = \alpha + \beta(JS)_i + u$$

The F-statistic values for SAT 1, SAT 2, and SAT 3 were 1.4055034, 0.03128509, and 2.7062353, respectively, none of which were able to reject the null hypothesis. While all

three R^2 values were expected to be quite low, the R^2 value associated with SAT 2 was again the lowest.

Lastly, the VES-related data (MEANLLLY) used, as with the linear regression case, the standardized direct labor regression coefficient value for the dependent variable and SAT 1, SAT 2, and SAT 3 as independent variables $(JS)_i$. The equation being

$$\left[\hat{\beta}_1 + \hat{\beta}_3(\overline{\ln K})\right] = \alpha + \beta(JS)_i + u$$

As with the previous regression, F-statistic values for SAT 1, SAT 2, and SAT 3 (1.299143, 1.6589047, and 2.5952107, respectively) failed to reject the null hypothesis in all three cases. Again, as expected, the R^2 values were quite low.

SUMMARY

In an early study, Dr. Herzberg admitted that there was very little direct evidence that workers' attitudes on specific job factors could be used to predict over-all attitudes. He also stated that there may be a general morale factor in job attitudes which could be independent of attitudes toward other factors (Herzberg, 1957: 81). The results of the final analysis found in Table VII seem to support this earlier analysis by Dr. Herzberg.

CHAPTER 5
CONCLUSION

SUMMARY

This thesis effort revolves around the question, "Is there any relationship between job satisfaction and productivity?" In order to answer this question, several steps were taken. Initially, a questionnaire which would capture a number of Dr. Herzberg's ingredients of a good job along with other questions that were felt to be relevant in determining the level of workers' job satisfaction was needed. Also, it was necessary to study several production functions, through the use of regression analysis, which would provide a means to explain the production data from Newark AFS. After deciding on three regression forms--linear, Cobb-Douglas, and VES--the regressions were run and, after corrections for autocorrelation, the marginal products for each case were developed. These marginal products were used as the independent variable values in the final analysis. Mean values for the appropriate questionnaire response groupings were calculated and were used as the dependent variable values in the final analysis. In the final analysis, nine simple linear regressions were run which were composed of three sets of dependent variables and and three sets of independent variables. The dependent variables, SAT 1, SAT 2, and SAT 3 represented a general job satisfaction question grouping, Dr. Herzberg's

ingredients of a good job, and another grouping of generalized job satisfaction questions, respectively (for a more detailed description, see Table II). The independent variables were calculated from the regression coefficients derived from the initial regressions.

The results of this final analysis can be found in Table VII. It is interesting to note that the null hypothesis ($\beta=0$) was only rejected in one case, and in that case, the regression coefficient was negative. The results of this study at Newark AFS, using this measurement technique, are consistent with the view that job satisfaction is not related to labor productivity. Simply stated, in this particular case, productivity is not a function of job satisfaction. To quote from Grigaliunas' article, "Has the Research Challenge to Motivation-Hygiene Theory Been Conclusive?":

> The supporting of any theory and the maintaining or improving of its utility can be effected only through further research and the elaboration of new theoretical and methodological ideas.
>
> (Grigaliunas: 840).

Perhaps, then, the question, "Is productivity related to job satisfaction?" has not yet been conclusively answered. Furthermore, perhaps AFLC should consider the caution given in the Orthodox Job Enrichment Program summary dated 14 April, 1975 in the implementation of job enrichment programs:

> . . .Orthodox Job Enrichment cannot be implemented using a 'cook book' approach. That is, we cannot apply changes made in one organization directly into another organization and conclude we will improve productivity and motivation. Each organization--each job--must be evaluated considering the specific motivators and hygiene factors relating to that organization in order to determine the most appropriate job changes.
> ("Orthodox Job Enrichment Program." 1975)

STUDY LIMITATIONS

The questionnaire for this thesis was developed by reviewing questions from several previous theses and studies and forming questions which were applicable to the workers at Newark AFS. As such, further applications should be made to determine the validity of the questionnaire. Also, if this questionnaire is used in a follow-on study, the questions used to identify the line items which the worker repairs should be modified to render them more understanable.

It should be stressed that the findings of this thesis are limited by the validity of 1) the questionnaire developed to measure job satisfaction; 2) the method of identifying a worker's level of job satisfaction with the line item he repairs; 3) the grouping of questionnaire responses; 4) the time span of the production data; 5) the regressions used to determine marginal products; and 6) the choice of variables used in the final analysis.

There are two additional limitations which should be understood and perhaps explored at a later date: 1) The production data used for this thesis was time sequenced over

a period of three years. Yet, in administering the questionnaire in a forty-eight-hour period (essentially, a point in time), the validity of comparing production data with the questionnaire results could be questioned. The fact that there was no significant explanation for differences in productivity for differing levels of measured job satisfaction across the production lines of Newark could, in part, be attributed to comparing time sequenced data with point data. Gathering job satisfaction data over time and comparing that data to the production data for the same time period is a method which should also be explored. 2) It should also be noted that with the production data, the data from calendar year 1975 contained additional noise not found in the remaining data. This was due to the implementation of a computerized data gathering system and the subsequent debugging of the operation. This additional noise was found in from zero to twenty percent of the production data, depending upon the particular line item. It was assumed that this noise would not significantly affect the final results of the analysis.

AREAS FOR FURTHER STUDY

The following areas should be considered for further study:

1) Additional studies should be conducted in order to ascertain whether the procedure used for relating job satisfaction and productivity in this thesis is truly valid.

Further attempts should be made to determine whether, in going across an organization, through the use of identifiable line items, differences in productivity can be explained by different levels of job satisfaction.

2) After the orthodox job enrichment program has been implemented and is in operation at Newark AFS, the questionnaire developed for this thesis should be administered and the results of the two studies compared to determine whether there has been any measurable change in the level of job satisfaction.

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Appendix A

Definitions and Notations

Throughout this thesis, the following terms will be defined as follows:

1. Direct Labor Hours. Direct Labor is generally defined as labor which adds utility to end items being repaired or manufactured and which can be reasonably, consistently, and economically identified with such products (Aerospace Guidance and Metrology Center, 1973: 1).

2. Direct Material. Material expended in productive operations where the unit of issue can be reasonably, consistently, and economically related to specific end products or jobs are defined as direct materials (Ibid).

3. End Item. An end item is the object being repaired at the depot. It is referenced in its component form, as it is worked on at the individual work stations.

4. Military Repair Depot. A military repair depot is an organization whose mission is to restore to operating condition faulty weapons systems, subsystems, or supporting equipment (Genet, 1974: 1).

5. Price Index or PI. In the context of this thesis, the price index is the wholesale price index (WPI) established by month by the Department of Commerce. In this study, PI provides a means of adjusting for material price fluctuations over time.

6. Job Enrichment. Simply stated, job enrichment is designing a job to provide meaningful work for the individual. Jobs are enriched through redesigning or restructuring them to provide greater opportunity for individual freedom

in performing the job and to make the content more interesting.

7. Job Satisfaction. A simple breakdown would show that there can be satisfaction with the specific activities of the job, often referred to as "Intrinsic job satisfaction;" with the place and working conditions under which the job is performed; or with specific factors such as economic rewards, security, or social prestige (Herzberg, 1957: 1).

8. Productivity. Productivity is the efficiency with which output is produced by the resources utilized. It refers to either man-hours worked or total hours paid for measurable labor output.

9. Quality of Worklife (QWL) Program. Quality of worklife research is concerned with how the relationship between individuals and features of their physical, social, and economic work envorinment affects those on-and-off the job attitudes and behaviors that society consider to be important (Glaser, 1976: 3).

10. Job Factors or Factors. Factors consist of the basic elements comprising job attitudes, such as age, sex, occupation, etc. (Herzberg, 1957: 70).

NOTATION

In the discussion concerning the correlation and regression techniques employed, the following abbreviations were used:

UNITSP	Units produced or end items, used with linear regression.
UNITSL	Natural logarithm of UNITSP, used with Cobb-Douglas and VES regressions.
DIRLHR	Direct Labor Hours, used with linear regression.
DIRLHL	Natural logarithm of DIRLHR, used with Cobb-Douglas and VES regressions.
DIRMAT	Direct Material Costs, divided by appropriate wage price index, used with linear regression.
DIRMAL	Natural logarithm of DIRMAT, used with Cobb-Douglas and VEW regressions.
DIRLML	DIRLHL multiplied by DIRMAL, used with VES regression.

In the discussion concerning autoregressive tranformation, the following variables were used:

UNITSF	The absolute difference between $UNITSP_i$ and $UNITSP_{i+1}$ for all values of $UNITS_i$, used with linear regression.
UNITSFL	Natural logarithm of UNITSF used with Cobb-Douglas and VES regressions.
DIRLHF	As with UNITSF, the absolute difference between $DIRLHR_i$ and $DIRLHR_{i+1}$ for all values of DIRLHR, used with linear regression.
DIRLHFL	Natural logarithm of DIRLHF, used with Cobb-Douglas and VES regressions.
DIRMAF	As with UNITSF, the absolute difference between $DIRMAT_i$ and $DIRMAT_{i+1}$ for all values of DIRMAT, used with linear regression.
DIRMAFL	Natural logarithm of DIRMAF, used with Cobb-Douglas and VES regressions.
DIRLMLF	As with DIRLML, DIRLHF multiplied by DIRMAF, with VES regression.

The following variables were developed for use in conjunction with condescriptive and regression programs:

MEANQ	The mean value of responses for each question on the questionnaire.
MEANU	The mean value of UNITSP for each end item.
MEANLR	The mean value of DIRLHR for each end item.
MEANLL	The mean value of DIRLHL for each end item.
MEANMT	The mean value of DIRMAT for each end item.
MEANML	The mean value of DIRMAL for each end item.
MEANLML	The mean value of DIRLML for each end item.

Appendix B

Job Satisfaction Questionnaire

PRIVACY STATEMENT

In accordance with paragraph 30, AFR 12-35, the following information is provided as required by the Privacy Act of 1974.

a. Authority

(1) 5 U.S.C. 301, Departmental Regulations: and/or

(2) 10 U.S.C. 80-12, Secretary of the Air Force, Powers and Duties, Delegation by.

b. Principal purposes. The survey is being conducted to collect information to be used in research aimed at illuminating and providing inputs to the solution of problems of interest to the Air Force and/or DOD.

c. Routine Uses. The survey data will be converted to information for use in research of management related problems. Results of the research based on the data provided, will be included in written Master's thesis and may also be included in published articles, reports, or texts. Distribution of the results of the research, based on the survey data, whether in written form or orally presented, will be unlimited.

d. Participation in this survey is entirely voluntary.

e. No adverse action of any kind may be taken against any individual who elects not to participate in any or all of this survey.

DIRECTIONS

This questionnaire has been developed to see of there is a way to relate a measure of job satisfaction of the members of an organization with the productivity of the organization. This questionnaire has been reviewed and approved by the Labor and Employee Relations Division, Directorate of Civilian Personnel (DPCE) HQ USAF; Directorate of Maintenance, Colonel Ralph L. Kitchens, and the President of American Federation of Government Employees (AFGE) Local 2221, Mr. Robert J. Novak, at Newark AFS.

Please do not put your name on this questionnaire. Your answers to these questions will be kept confidential, and no attempt will be made to identify any individual by name. Your frank, honest answers to each question are desired and needed. I would like you to answer all of the questions in this questionnaire. If you feel however, that any item requests information that you consider personal, you may skip that question.

Please read each question carefully, then read each of the answers given. Choose the statement which best answers the question for you. You will have as much time as necessary to complete the questionnaire.

The results of these questionnaires will be incorporated into a Master's thesis by Captain Don Jones to be completed in September 1977. A copy of the thesis will be placed on file in the Productivity Enhancement Office (MASE) upon completion.

PLEASE DO NOT PUT YOUR NAME ON THIS QUESTIONNAIRE

JOB SATISFACTION QUESTIONNAIRE

1. Please circle the letter identigying the line item you work with at this time (if you work with more than one item, skip this question and begin on question 2; if you do work with only one item, complete this question and go to question 3).

(a) NS20	(b) Titan	(c) N10	(d) NS17	(e) LN15
(f) KT76	(g) KT73	(h) C5A	(i) VM8	(j) LN14
(k) KT71	(l) N16	(m) LN12	(n) T38	(o) G9
(p) D7900	(q) W2171	(r) SR3	(s) G200	(t) AB2171
(u) other				

2. If you work on more than one line item, please place the appropriate letters (from the previous question) in the blanks provided and circle the approximate ammount of time you would spend on each item in an average 40-hour week.

Item Letter	Hours spent on each item in a 40-hour week			
______	1 to 10	11 to 20	21 to 30	31 to 39
______	1 to 10	11 to 20	21 to 30	31 to 39
______	1 to 10	11 to 20	21 to 30	31 to 39
______	1 to 10	11 to 20	21 to 30	31 to 39

3. How long have you been working on this (these) line item(s)? Please circle the appropriate letter.

(a) less than 6 months

(b) more than 6 months but less than 1 year

(c) more than 1 year but less than 2 years

(d) more than 2 years but less than 3 years

(e) more than 3 years but less than 4 years

(f) more than 4 years

NOTE: Have you worked on any line item(s) at Newark prior to the item you are working with now?

( ) Yes ( )No (Please check the appropriate answer)

(If you answered <u>yes</u> to the above and worked on only one line item, go to question 4).
(If you answered <u>yes</u> to the above and worked on more than one line item, go to question 5).
(If you answered <u>no</u> to the above, please go to question 7).

4. Please circle the letter identifying the line item you worked with previously at Newark, then continue on to question 6.

(a) NS20	(b) Titan	(c) N10	(d) NS17	(e) LN15
(f) KT76	(g) KT73	(h) C5A	(i) VM8	(j) LN14
(k) KT71	(l) N16	(m) LN12	(n) T38	(o) G9
(p) D7900	(q) W2171	(r) SR3	(s) G200	(t) AB2171
(u) other				

5. If you previously worked on more than one line item, please place the appropriate letters (from the previous question) in the blanks provided and circle the approximate amount of time you would spend on each item in an average 40-hour week.

Item Letter	Hours spent on each item in a 40-hour week			
______	1 to 10	11 to 20	21 to 30	31 to 39
______	1 to 10	11 to 20	21 to 30	31 to 39
______	1 to 10	11 to 20	21 to 30	31 to 39
______	1 to 10	11 to 20	21 to 30	31 to 39

6. How long did you work on this (these) line item(s)? Please circle the appropriate letter.

(a) less than 6 months

(b) more than 6 months but less than 1 year

(c) more than 1 year but less than 2 years

(d) more than 2 years but less than 3 years

(e) more than 3 years but less than 4 years

(f) more than 4 years

The following questions concern your present primary job at Newark. Please circle the appropriate letter.

7. Which <u>one</u> of the following represents <u>how much of the time</u> you feel satisfied with your present job?

(a) never

(b) seldom

(c) occasionally

(d) about half of the time

(e) a good deal of the time

(f) most of the time

(g) all of the time

8. Choose the <u>one</u> statement which best describes how well you like your job.

(a) I hate it

(b) I dislike it

(c) I do not like it

(d) I am indifferent to it

(e) I like it

(f) I am enthusiastic about it

(g) I love it

9. Which one of the following statements best expresses how you would feel about changing your job?

(a) I would quite at once if I could

(b) I would take almost any other job in which I could earn as much as I am earning now

(c) I would like to change both my job and my occupation

(d) I would like to exchange my present job for another one

(e) I am not eager to change my job, but I would do so if I could get a better job

(f) I cannot think of any jobs for which I would exchange jobs

(g) I would not exchange my job for any other

10. Which <u>one</u> of the following statements shows how <u>you</u> think <u>you</u> compare with the other people you work with?

(a) No one dislikes his job more than I dislike mine

(b) I dislike my job much more than most people dislike theirs

(c) I dislike my job more than most people dislike theirs

(d) I like my job about as well as most people like theirs

(e) I like my job better than most people like theirs

(f) I like my job much better than most people like theirs

(g) No one likes their job better than I like mine

For the following 15 questions, please circle the number that best indicates your attitude.

<u>Sample question</u>: How satisfied are you with your work environment?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

11. How satisfied are you with the feedback you receive in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

12. What type of feedback do you get in your job?

1	2	3	4	5	6	7
Ill-timed Evaluative			None			Instant Non-Evaluative

13. Do you have any communication with the people who use the items you repair?

1	2	3	4	5	6	7
No Communication			Some Communication			Frequent Communication

14. Are you satisfied with the degree to which you can continue your learning while working at Newark?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

15. To what degree are you satisfied with your opportunity to schedule your own work in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

16. How satisfied are you with the extent to which the item(s) you repair can be identified with you?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

17. How satisfied are you with the extent to which you can exercise your personal expertise in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

18. How satisfied are you with the control you have over the parts you use for repairing your line items?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

The following question is concerned with your freedom to communicate directly with the other workers concerning work they do which directly affects the items you repair. To be specific, can you talk with them directly concerning either a problem or a compliment, or do you have to go through channels?

19. How satisfied are you with the extent to which you can communicate with someone outside your job area?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

20. How satisfied are you with the sense of achievement you realize in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

21. How satisfied are you with the responsibility you have in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

22. To what degree are you satisfied with the written and oral rules, regulations, and directives you have in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

23. How satisfied are you with the way your job affects your personal life?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

24. How satisfied are you with the work itself in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

25. To what degree are you satisfied with your opportunity for growth in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

Appendix C

Variables SAT 1, SAT 2, and SAT 3

SAT 1

7. Which one of the following represents how much of the time you feel satisfied with your present job?

(a) never

(b) seldom

(c) occasionally

(d) about half of the time

(e) a good deal of the time

(f) most of the time

(g) all of the time

8. Choose the one statement which best describes how well you like your job.

(a) I hate it

(b) I dislike it

(c) I do not like it

(d) I am indifferent to it

(e) I like it

(f) I am enthusiastic about it

(g) I love it

24. How satisfied are you with the work itself in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

SAT 2

11. How satisfied are you with the feedback you receive in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

12. What type of feedback do you get in your job?

1	2	3	4	5	6	7
Ill-timed Evaluative			None			Instant Non-Evaluative

13. Do you have any communication with the people who use the items you repair?

1	2	3	4	5	6	7
No Communication			Some Communication			Frequent Communication

14. Are you satisfied with the degree to which you can continue your learning while at Newark?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

15. To what degree are you satisfied with your opportunity to schedule your own work in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

16. How satisfied are you with the extent to which the item(s) you repair can be identified with you?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

17, How satisfied are you with the extent to which you can exercise your personal expertise in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

18. How satisfied are you with the control you have over the parts you use for repairing your line items?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

19. How satisfied are you with the extent to which you can communicate with someone outside your job area?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

SAT 3

20. How satisfied are you with the sense of achievement you realize in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

21. How satisfied are you with the responsibility you have in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral		Highly Satisfied	

22. To what degree are you satisfied with the written and oral rules, regulations, and directives you have in your job?

1	2	3	4	5	6	7
Highly Dissatisfied			Neutral			Highly Satisfied

Appendix D

Questionnaire Results

Line Item: all end items Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.683	2.026	7.000	2.000
8	4.828	0.790	7.000	2.000
9	4.362	1.770	7.000	1.000
10	5.542	0.811	7.000	2.000
11	3.336	2.569	7.000	1.000
12	3.735	1.744	7.000	1.000
13	2.582	3.878	7.000	1.000
14	3.114	3.279	7.000	1.000
15	4.566	3.366	7.000	1.000
16	4.323	3.376	7.000	1.000
17	4.291	3.719	7.000	1.000
18	2.741	3.142	7.000	1.000
19	3.913	3.120	7.000	1.000
20	4.336	3.253	7.000	1.000
21	4.431	3.058	7.000	1.000
22	3.558	3.091	7.000	1.000
23	4.405	3.096	7.000	1.000
24	4.825	2.065	7.000	1.000
25	2.344	2.359	7.000	1.000

Line Item: LN12 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.559	1.940	7.000	2.000
8	4.814	0.775	7.000	2.000
9	4.373	1.583	7.000	1.000
10	4.508	0.909	7.000	2.000
11	3.356	2.992	7.000	1.000
12	3.763	2.012	7.000	1.000
13	2.373	3.790	7.000	1.000
14	3.305	3.664	7.000	1.000
15	4.169	3.764	7.000	1.000
16	4.254	4.193	7.000	1.000
17	4.051	3.877	7.000	1.000
18	2.814	3.327	7.000	1.000
19	3.915	3.010	7.000	1.000
20	4.186	3.913	7.000	1.000
21	4.153	3.959	7.000	1.000
22	3.508	3.151	7.000	1.000
23	4.322	3.567	7.000	1.000
24	4.593	2.590	7.000	1.000
25	2.288	2.174	6.000	1.000

Line Item: LN14 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.633	1.964	7.000	2.000
8	5.000	0.552	7.000	4.000
9	4.300	1.941	7.000	1.000
10	4.667	0.713	6.000	3.000
11	3.267	2.961	6.000	1.000
12	3.500	1.707	6.000	1.000
13	2.433	3.702	7.000	1.000
14	2.467	2.189	6.000	1.000
15	4.167	3.799	7.000	1.000
16	4.200	3.614	7.000	1.000
17	3.833	4.075	7.000	1.000
18	2.300	2.976	7.000	1.000
19	3.633	3.068	7.000	1.000
20	4.067	3.857	7.000	1.000
21	4.200	3.752	7.000	1.000
22	3.333	3.264	7.000	1.000
23	4.333	4.023	7.000	1.000
24	4.667	2.230	7.000	1.000
25	2.200	2.166	5.000	1.000

Line Item: LN15 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.938	1.796	7.000	3.000
8	4.875	0.517	6.000	4.000
9	4.313	2.629	7.000	1.000
10	4.688	0.762	6.000	4.000
11	3.313	2.362	6.000	1.000
12	3.500	1.067	6.000	2.000
13	2.750	4.067	6.000	1.000
14	2.688	2.496	6.000	1.000
15	4.375	2.783	7.000	1.000
16	4.125	3.183	7.000	2.000
17	3.938	3.129	7.000	1.000
18	2.625	4.250	7.000	1.000
19	4.313	2.496	7.000	2.000
20	4.938	2.063	7.000	2.000
21	5.000	1.200	6.000	2.000
22	3.188	2.563	6.000	1.000
23	4.063	3.262	7.000	1.000
24	4.750	1.933	6.000	2.000
25	2.438	1.996	5.000	1.000

Line Item: VM8 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	3.667	4.267	7.000	2.000
8	4.167	2.167	6.000	2.000
9	3.000	1.600	4.000	1.000
10	3.833	1.367	5.000	2.000
11	2.333	1.067	4.000	1.000
12	2.833	1.767	5.000	1.000
13	2.667	5.867	7.000	1.000
14	2.500	3.900	5.000	1.000
15	4.333	7.467	7.000	1.000
16	3.167	6.567	7.000	1.000
17	3.500	6.300	7.000	1.000
18	2.833	4.567	6.000	1.000
19	3.667	3.067	5.000	1.000
20	3.167	7.367	7.000	1.000
21	3.833	6.567	7.000	1.000
22	2.667	2.667	5.000	1.000
23	3.333	3.867	5.000	1.000
24	4.500	3.500	6.000	1.000
25	2.000	3.500	6.000	1.000

Line Item: G200 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.750	2.046	7.000	2.000
8	4.679	0.597	6.000	3.000
9	4.179	2.078	7.000	1.000
10	4.571	0.772	6.000	3.000
11	3.321	1.782	6.000	1.000
12	3.464	1.369	6.000	1.000
13	2.714	4.212	7.000	1.000
14	3.107	2.840	6.000	1.000
15	4.071	3.254	7.000	1.000
16	4.250	3.750	7.000	1.000
17	3.893	2.840	7.000	1.000
18	2.607	3.136	7.000	1.000
19	3.857	2.646	7.000	1.000
20	3.964	3.517	7.000	1.000
21	4.036	3.517	6.000	1.000
22	3.429	3.439	7.000	1.000
23	4.214	3.582	7.000	1.000
24	4.679	2.374	6.000	1.000
25	2.179	1.485	5.000	1.000

Line Item: T38 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.429	3.286	6.000	2.000
8	4.714	0.905	6.000	3.000
9	4.714	1.571	6.000	2.000
10	4.429	0.952	6.000	3.000
11	3.286	1.905	5.000	2.000
12	4.143	0.810	5.000	3.000
13	2.000	5.000	7.000	1.000
14	3.286	5.905	7.000	1.000
15	5.000	2.000	7.000	3.000
16	3.429	2.286	5.000	1.000
17	5.000	1.667	7.000	3.000
18	3.571	3.619	6.000	1.000
19	3.857	2.476	6.000	1.000
20	4.143	4.143	7.000	1.000
21	4.286	2.571	7.000	2.000
22	3.571	2.952	6.000	2.000
23	3.714	5.905	7.000	1.000
24	4.286	3.238	7.000	2.000
25	2.286	3.238	6.000	1.000

Line Item: TITAN Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.622	2.331	7.000	2.000
8	4.756	1,098	7.000	2.000
9	4.444	1.889	7.000	1.000
10	4.444	0.843	7.000	2.000
11	3.133	2.618	7.000	1.000
12	3.667	2.045	7.000	1.000
13	2.600	4.109	7.000	1.000
14	3.022	3.340	7.000	1.000
15	4.467	3.755	7.000	1.000
16	4.356	3.053	7.000	1.000
17	4.222	4.631	7.000	1.000
18	2.356	2.734	7.000	1.000
19	3.822	3.468	7.000	1.000
20	4.267	3.245	7.000	1.000
21	4.600	2.882	7.000	1.000
22	3.644	3.371	7.000	1.000
23	4.600	2.927	7.000	1.000
24	4.622	2.331	7.000	1.000
25	1.889	1.601	5.000	1.000

AD-A045 983   AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OHIO   SCH--ETC   F/G 5/9
AN ANALYSIS OF THE RELATIONSHIP BETWEEN JOB SATISFACTION AND LA--ETC(U)
SEP 77   D R JONES

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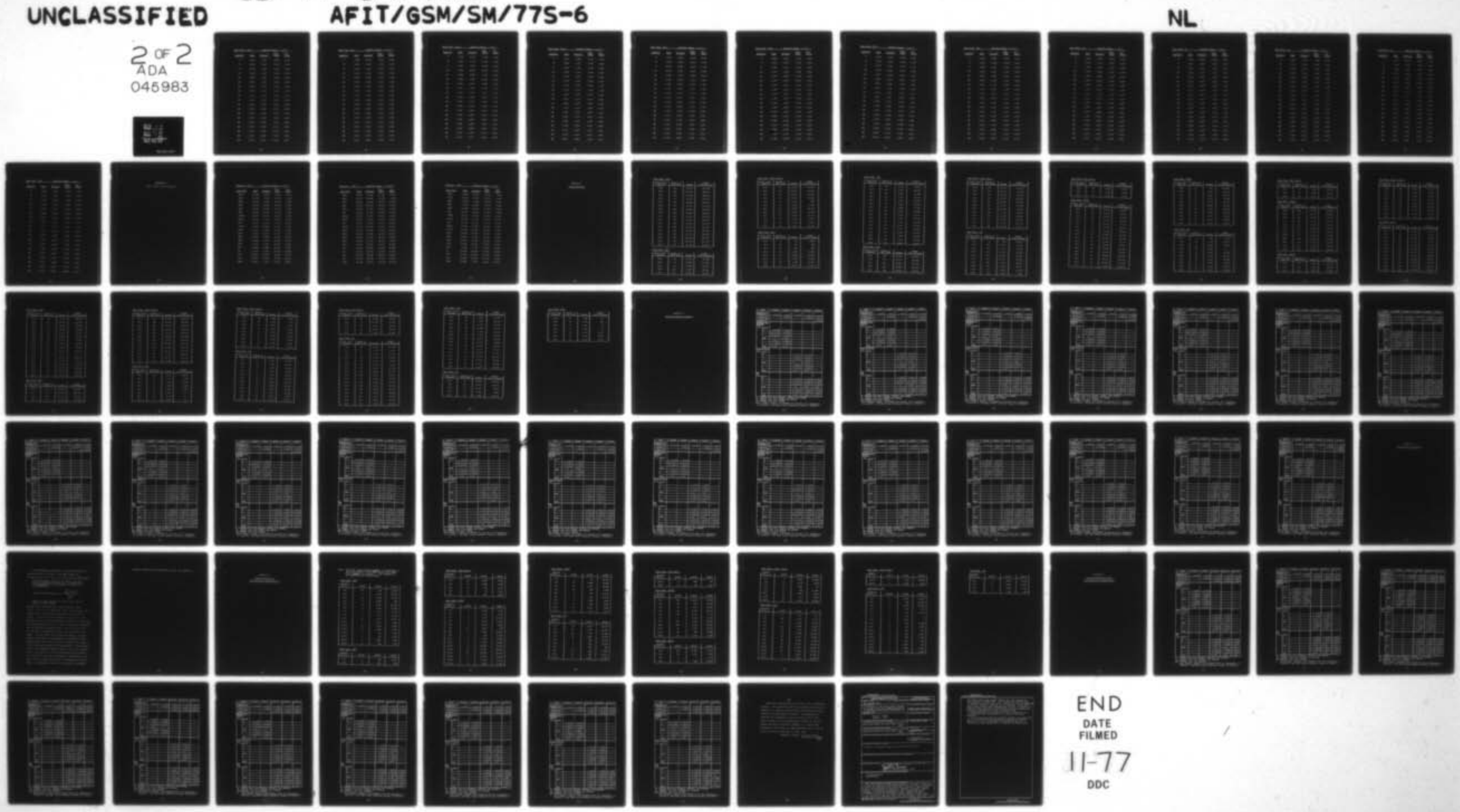

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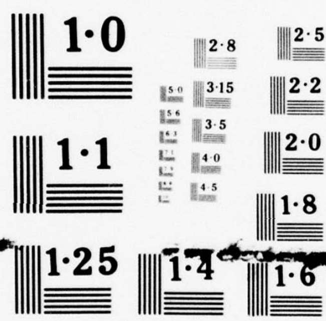

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Line Item: D7900 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	5.000	1.600	6.000	3.000
8	4.833	0.567	6.000	4.000
9	4.667	1.867	6.000	2.000
10	4.333	1.867	6.000	2.000
11	3.667	1.867	5.000	2.000
12	4.000	1.600	5.000	2.000
13	1.833	1.367	4.000	1.000
14	4.333	4.267	7.000	1.000
15	5.500	1.500	7.000	4.000
16	4.500	1.900	6.000	2.000
17	5.333	1.467	7.000	4.000
18	4.000	2.800	6.000	2.000
19	4.167	2.967	6.000	1.000
20	5.167	2.167	7.000	3.000
21	4.833	2.567	7.000	3.000
22	4.167	2.167	6.000	2.000
23	4.833	2.967	7.000	2.000
24	5,167	1.367	7.000	4.000
25	3.000	3.200	6.000	1.000

Line Item: SR3 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	3.800	2.200	6.000	2.000
8	4.600	0.300	5.000	4.000
9	3.800	3.200	5.000	1.000
10	4.400	0.300	5.000	4.000
11	2.400	2.300	5.000	1.000
12	4.000	0.500	5.000	3.000
13	1.200	0.200	2.000	1.000
14	2.000	1.500	4.000	1.000
15	4.600	1.300	6.000	3.000
16	3.400	3.800	6.000	1.000
17	4.000	1.500	5.000	3.000
18	1.400	0.300	2.000	1.000
19	3.400	6.300	7.000	1.000
20	3.400	2.800	6.000	2.000
21	4.200	2.700	7.000	3.000
22	3.000	2.000	5.000	2.000
23	2.400	1.300	4.000	1.000
24	4.600	3.300	7.000	3.000
25	2.200	2.700	5.000	1.000

Line Item: AB2171 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	5.034	2.749	7.000	2.000
8	4.621	1.172	6.000	2.000
9	4.310	1.865	6.000	1.000
10	4.448	0.970	6.000	2.000
11	3.828	2.648	7.000	1.000
12	3.966	1.320	6.000	2.000
13	2.483	4.973	7.000	1.000
14	3.241	3.618	7.000	1.000
15	5.138	2.480	7.000	1.000
16	4.690	2.865	7.000	1.000
17	4.552	3.113	7.000	1.000
18	2.966	3.117	6.000	1.000
19	4.379	3.387	7.000	1.000
20	4.655	2.805	7.000	1.000
21	4.690	3.293	7.000	1.000
22	4.138	3.480	7.000	1.000
23	4.138	3.695	7.000	1.000
24	5.134	1.677	7.000	1.000
25	2.793	3.170	7.000	1.000

Line Item: W2171 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	5.412	1.882	7.000	2.000
8	4.824	1.154	7.000	2.000
9	4.412	1.382	6.000	2.000
10	4.824	1.154	7.000	2.000
11	4.353	2.243	7.000	2.000
12	4.176	1.654	7.000	2.000
13	1.941	2.809	7.000	1.000
14	2.529	3.640	7.000	1.000
15	5.529	1.890	7.000	3.000
16	4.824	2.529	7.000	2.000
17	4.824	3.279	7.000	2.000
18	3.118	3.735	7.000	1.000
19	4.824	3.779	7.000	1.000
20	5.000	2.500	7.000	1.000
21	5.000	3.500	7.000	1.000
22	4.765	2.941	7.000	1.000
23	4.471	3.890	7.000	1.000
24	5.176	2.404	7.000	1.000
25	2.412	2.882	7.000	1.000

Line Item: KT73 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.500	2.000	6.000	2.000
8	4.875	1.839	6.000	2.000
9	3.875	2.982	6.000	1.000
10	4.750	1.929	6.000	2.000
11	3.000	1.143	5.000	2.000
12	3.750	2.500	7.000	2.000
13	1.250	0.500	3.000	1.000
14	3.750	3.357	6.000	1.000
15	3.875	4.125	6.000	1.000
16	4.500	3.429	7.000	1.000
17	4.750	5.643	7.000	1.000
18	2.000	3.714	6.000	1.000
19	3.750	3.357	7.000	2.000
20	5.125	3.839	7.000	1.000
21	5.000	1.714	6.000	3.000
22	2.750	2.500	5.000	1.000
23	4.250	2.214	6.000	1.000
24	4.875	0.982	7.000	4.000
25	2.375	1.982	5.000	1.000

Line Item: NS20 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.690	1.936	6.000	2.000
8	5.138	0.480	7.000	4.000
9	4.862	1.123	7.000	2.000
10	4.552	0.756	6.000	2.000
11	3.414	2.466	6.000	1.000
12	3.621	1.672	6.000	1.000
13	3.448	3.613	7.000	1.000
14	3.586	3.180	7.000	1.000
15	5.000	2.786	7.000	1.000
16	4.586	3.251	7.000	1.000
17	4.552	3.613	7.000	1.000
18	3.069	3.209	7.000	1.000
19	3.724	2.493	7.000	1.000
20	4.828	1.576	7.000	2.000
21	4.690	2.507	7.000	1.000
22	3.414	2.466	7.000	1.000
23	4.828	2.148	7.000	2.000
24	5.034	1.749	7.000	2.000
25	2.586	2.608	6.000	1.000

Line Item: NS17 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.595	1.905	6.000	2.000
8	4.857	0.613	7.000	2.000
9	4.452	1.620	6.000	1.000
10	4.476	0.646	6.000	2.000
11	3.214	3.246	6.000	1.000
12	3.524	1.816	6.000	1.000
13	3.167	4.386	7.000	1.000
14	3.119	3.181	7.000	1.000
15	5.286	2.209	7.000	1.000
16	4.476	3.621	7.000	1.000
17	4.524	3.914	7.000	1.000
18	2.476	3.085	7.000	1.000
19	3.571	3.422	7.000	1.000
20	4.262	3.076	7.000	1.000
21	4.476	2.890	7.000	1.000
22	3.333	2.959	7.000	1.000
23	4.667	2.472	7.000	1.000
24	5.095	1.747	7.000	2.000
25	2.357	2.967	6.000	1.000

Line Item: KT71 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.625	0.839	6.000	3.000
8	5.000	0.286	6.000	4.000
9	4.250	1.357	5.000	2.000
10	4.750	0.500	6.000	4.000
11	3.625	1.982	6.000	2.000
12	4.625	1.696	7.000	3.000
13	2.625	4.554	7.000	1.000
14	4.250	4.214	7.000	2.000
15	3.875	5.268	7.000	1.000
16	4.625	2.839	7.000	2.000
17	5.125	3.554	7.000	1.000
18	3.750	3.357	6.000	1.000
19	4.625	1.411	7.000	3.000
20	4.625	2.839	6.000	1.000
21	4.375	1.982	6.000	2.000
22	3.250	2.214	6.000	1.000
23	4.875	0.982	6.000	4.000
24	5.000	0.857	7.000	4.000
25	2.875	2.696	5.000	1.000

Line Item: N16 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.250	1.929	6.000	2.000
8	4.375	1.125	5.000	2.000
9	4.250	1.929	5.000	1.000
10	4.375	1.125	5.000	2.000
11	2.125	0.982	4.000	1.000
12	3.625	1.125	5.000	2.000
13	2.000	2.000	4.000	1.000
14	1.750	0.500	3.000	1.000
15	4.250	5.643	7.000	1.000
16	2.875	1.554	4.000	1.000
17	3.750	2.500	6.000	1.000
18	2.875	1.839	4.000	1.000
19	3.625	5.696	7.000	1.000
20	1.750	0.786	3.000	1.000
21	3.250	0.500	4.000	2.000
22	4.250	4.500	7.000	1.000
23	4.000	3.714	6.000	1.000
24	5.250	1.643	7.000	4.000
25	1.125	0.125	2.000	1.000

Line Item: G9 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.833	0.967	6.000	4.000
8	5.167	0.567	6.000	4.000
9	4.167	2.167	6.000	2.000
10	4.833	0.167	5.000	4.000
11	4.000	2.800	7.000	3.000
12	4.333	0.667	5.000	3.000
13	2.333	3.867	6.000	1.000
14	3.333	5.067	7.000	1.000
15	4.667	3.867	7.000	1.000
16	4.000	3.600	7.000	2.000
17	5.333	1.067	7.000	4.000
18	3.167	1.367	5.000	2.000
19	4.667	4.267	7.000	1.000
20	4.000	5.600	7.000	1.000
21	4.667	3.467	7.000	2.000
22	3.833	4.967	7.000	1.000
23	5.000	3.200	7.000	2.000
24	5.500	0.700	7.000	5.000
25	3.167	5.767	7.000	1.000

Line Item: C5A Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.667	2.424	7.000	2.000
8	4.917	0.992	6.000	3.000
9	4.333	2.061	7.000	2.000
10	4.833	0.515	6.000	4.000
11	2.917	2.083	6.000	1.000
12	4.000	3.818	7.000	2.000
13	2.917	3.174	6.000	1.000
14	3.000	1.818	5.000	1.000
15	3.417	3.902	7.000	1.000
16	3.583	3.174	7.000	1.000
17	3.167	5.061	7.000	1.000
18	2.833	3.061	6.000	1.000
19	3.750	3.295	7.000	1.000
20	4.500	2.273	6.000	1.000
21	3.583	3.174	6.000	1.000
22	2.917	2.083	5.000	1.000
23	4.417	1.902	7.000	2.000
24	4.333	2.242	6.000	1.000
25	2.333	1.879	5.000	1.000

Line Item: N10 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.917	1.356	6.000	2.000
8	5.000	0.364	6.000	4.000
9	4.667	0.970	6.000	2.000
10	4.417	0.265	5.000	4.000
11	3.583	2.992	7.000	1.000
12	4.167	1.788	6.000	2.000
13	3.000	4.000	7.000	1.000
14	3.333	3.333	7.000	1.000
15	4.750	3.114	7.000	2.000
16	5.333	1.515	7.000	4.000
17	4.750	3.114	7.000	1.000
18	3.000	2.182	5.000	1.000
19	3.500	2.273	7.000	1.000
20	4.917	1.538	7.000	3.000
21	4.917	2.265	7.000	3.000
22	4.250	3.295	7.000	1.000
23	5.000	1.636	7.000	3.000
24	5.000	2.000	7.000	2.000
25	2.833	3.061	7.000	1.000

Line Item: KT76 Possible Range: 1 to 7

Question	Mean	Variance	High Value	Low Value
7	4.400	0.800	5.000	3.000
8	5.000	0.500	6.000	4.000
9	3.600	2.800	5.000	1.000
10	4.800	0.700	6.000	4.000
11	3.200	1.700	5.000	2.000
12	3.600	1.800	5.000	2.000
13	1.800	3.200	5.000	1.000
14	4.400	3.300	6.000	2.000
15	4.200	1.700	6.000	3.000
16	4.600	4.300	7.000	2.000
17	5.200	5.700	7.000	1.000
18	3.400	5.300	6.000	1.000
19	4.200	3.700	7.000	2.000
20	4.800	2.700	6.000	2.000
21	5.000	0.500	6.000	4.000
22	3.000	0.500	4.000	2.000
23	4.600	1.800	6.000	3.000
24	5.400	0.800	7.000	5.000
25	3.000	2.000	5.000	2.000

Appendix E

SAT 1, SAT 2, SAT 3 Results

Variable: SAT 1 Possible Range: 3 to 21

Line Item	Mean	Variance	High Value	Low Value
LN12	13.966	11.895	21.000	5.000
LN14	14.300	9.597	19.000	7.000
LN15	14.563	8.662	19.000	9.000
VM8	12.333	22.667	19.000	6.000
G200	14.107	10.766	19.000	6.000
T38	13.429	16.952	19.000	7.000
TITAN	14.000	12.273	21.000	8.000
D7900	15.000	9.200	19.000	11.000
SR3	13.000	11.000	17.000	10.000
AB2171	14.690	12.865	19.000	5.000
W2171	15.412	13.382	21.000	5.000
KT73	14.250	10.214	17.000	8.000
NS20	14.862	6.266	19.000	10.000
NS17	14.548	6.742	19.000	8.000
KT71	14.625	2.554	16.000	11.000
N16	13.875	11.839	18.000	8.000
G9	15.500	5.900	19.000	13.000
C5A	13.917	11.174	19.000	8.000
N10	14.917	6.265	19.000	10.000
KT76	14.800	2.700	16.000	12.000

Variable: SAT 2 Possible Range: 8 to 56

Line Item	Mean	Variance	High Value	Low Value
LN12	28.441	93.949	50.500	8.000
LN14	26.417	88.088	48.000	8.000
LN15	28.219	72.699	48.000	17.500
VM8	25.250	127.875	38.500	10.000
G200	27.893	70.321	48.000	8.000
T38	29.857	70.393	43.000	18.000
TITAN	28.244	86.246	48.000	8.000
D7900	33.500	72.600	43.000	18.000
SR3	23.200	38.700	31.000	16.000
AB2171	31.345	104.448	50.500	10.000
W2171	31.853	91.024	47.000	18.000
KT73	27.250	90.286	44.000	10.000
NS20	31.483	77.473	48.000	18.500
NS17	29.988	80.360	48.000	8.000
KT71	33.000	63.571	44.000	23.500
N16	24.000	71.071	34.500	10.000
G9	31.667	87.167	47.000	20.500
C5A	26.125	88.642	48.000	15.500
N10	31.542	46.066	47.000	22.000
KT76	31.200	83.075	44.000	21.000

Variable: SAT 3 Possible Range: 3 to 21

Line Item	Mean	Variance	High Value	Low Value
LN12	11.847	22.511	21.000	3.000
LN14	11.600	19.421	18.000	3.000
LN15	13.125	9.983	18.000	9.000
VM8	9.667	30.267	17.000	4.000
G200	11.429	18.772	17.000	3.000
T38	12.000	20.667	19.000	6.000
TITAN	12.511	19.983	21.000	3.000
D7900	14.167	13.367	19.000	10.000
SR3	10.600	15.300	17.000	7.000
AB2171	13.483	22.687	21.000	3.000
W2171	14.765	20.316	21.000	3.000
KT73	12.875	20.696	18.000	5.000
NS20	12.931	11.067	20.000	6.000
NS17	12.071	17.336	20.000	3.000
KT71	12.250	14.500	18.000	6.000
N16	9.250	7.357	12.000	5.000
G9	12.500	36.300	21.000	6.000
C5A	11.000	16.727	17.000	3.000
N10	14.083	11.902	21.000	9.000
KT76	12.800	3.700	15.000	10.000

Appendix F

Production Data

Line Item: LN12

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/1	561	81,081	294,516
73/2	604	112,510	428,332
73/3	518	94,308	386,053
73/4	517	79,031	300,514
74/1	470	69,508	189,167
74/2	514	70,333	219,909
74/3	514	72,640	310,947
74/4	565	82,256	236,069
75/1	569	87,250	332,146
75/2	460	75,704	308,607
75/3	509	40,980	173,028
75/4	620	89,109	490,346
76/1	558	56,025	357,852
76/2	536	61,712	389,769
76/3	533	64,523	347,917
76/4	572	88,662	411,069
76/5	512	71,541	303,559

Line Item: LN14

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/1	95	12,309	51,638
73/2	75	12,887	105,469
73/3	75	7,887	20,970
73/4	105	11,973	88,912
74/1	111	15,923	89,361

Line Item: LN14 (cont.)

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
74/2	74	12,823	101,946
74/3	76	14,117	37,954
74/4	76	16,816	45,723
75/1	70	15,045	27,855
75/2	47	6,731	988
75/3	45	2,524	6,156
75/4	61	9,812	16,134
76/1	78	5,529	12,805
76/2	77	6,239	20,198
76/3	81	5,701	21,867
76/4	83	7,301	20,643
76/5	72	6,642	19,740

Line Item: LN15

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
75/2	1	44	3,585
75/3	10	577	308
75/4	18	850	735
76/1	50	2,537	8,990
76/2	64	5,086	16,516
76/3	75	5,508	13,399
76/4	63	5,538	16,511
76/5	54	6,341	12,637

Line Item: VM8

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/1	80	3,133	35,703
73/2	104	2,768	28,828
73/3	66	2,028	14,896
73/4	112	3,794	24,470
74/1	63	2,118	20,880
74/2	79	2,331	18,342
74/3	96	2,686	17,469
74/4	138	2,865	14,848
75/1	139	4,354	36,095
75/2	98	3,900	36,197
75/3	86	3,204	26,568
75/4	127	4,321	36,552
76/1	139	3,653	54,318
76/2	103	4,642	57,751
76/3	97	2,396	32,996
76/4	158	3,271	36,502
76/5	89	2,866	38,300

Line Item: G200

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/1	282	33,572	126,871
73/2	241	30,344	107,851
73/3	305	46,462	209,506
73/4	207	34,887	165,415
74/1	202	34,983	116,852

Line Item: G200 (cont.)

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
74/2	282	36,703	141,957
74/3	206	24,473	91,225
74/4	313	37,669	116,658
75/1	274	31,449	115,374
75/2	241	30,871	137,185
75/3	263	10,697	43,428
75/4	136	13,000	81,696
76/1	253	7,423	58,292
76/2	293	14,335	116,327
76/3	273	28,486	162,018
76/4	203	27,360	119,732
76/5	270	31,488	110,188

Line Item: T38

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
74/1	5	381	40,148
74/2	139	6,047	35,593
74/3	139	7,013	40,524
74/4	170	8,771	17,946
75/1	230	11,794	33,531
75/2	203	11,247	29,930
75/3	261	9,325	28,943
75/4	156	5,735	20,731
76/1	45	2,662	13,252
76/2	36	1,418	5,278

Line Item: T38 (cont.)

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
76/3	29	1,293	6,540
76/4	44	1,439	3,294
76/5	45	1,862	4,291

Line Item: TITAN

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/1	36	22,336	60,206
73/2	31	24,522	63,310
73/3	30	23,410	61,390
73/4	36	27,185	89,906
74/1	33	22,540	64,854
74/2	25	20,446	58,997
74/3	36	24,523	58,409
74/4	43	29,449	91,356
75/1	38	28,864	75,808
75/2	30	24,472	51,117
75/3	39	28,885	97,402
75/4	41	47,776	175,379
76/1	74	25,465	89,108
76/2	34	48,239	203,432
76/3	39	35,021	124,316
76/4	32	38,626	141,448
76/5	34	35,026	113,857

Line Item: D7900

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
74/3	10	845	104,391
74/4	12	1,020	20,616
75/1	37	3,084	80,414
75/2	64	5,061	37,548
75/3	79	4,518	32,701
75/4	73	4,872	44,612
76/1	80	5,723	54,662
76/2	80	7,683	50,278
76/3	80	7,138	46,302
76/4	70	6,127	44,638
76/5	84	6,766	46,630

Line Item: SR3

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
74/1	2	200	6,177
74/2	78	4,529	32,325
74/3	55	3,085	70,582
74/4	76	3,859	-0-
75/1	49	2,590	24,906
75/2	52	3,159	16,011
75/3	59	2,520	20,282
75/4	64	1,985	20,666
76/1	80	2,908	28,313
76/2	67	1,914	15,236

Line Item: SR3 (cont.)

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
76/3	76	3,322	25,822
76/4	67	2,680	25,511
76/5	80	3,011	20,374

Line Item: AB2171

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
74/2	334	10,244	82,884
74/3	726	25,436	128,982
74/4	672	77,602	25,923
75/1	639	24,533	117,203
75/2	603	22,469	88,022
75/3	709	17,296	94,453
75/4	707	18,789	109,139
76/1	605	13,721	84,249
76/2	739	19,326	132,748
76/3	659	17,799	107,288
76/4	610	17,321	78,400
76/5	598	19,830	86,268

Line Item: W2171

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
74/2	28	1,259	22,703
74/3	123	5,821	34,618
74/4	141	7,734	32,480

Line Item: W2171 (cont.)

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
75/1	141	7,733	27,927
75/2	134	6,908	6,999
75/3	140	3,988	26,879
75/4	153	5,752	24,123
76/1	226	8,042	24,274
76/2	181	7,680	36,594
76/3	214	9,333	39,436
76/4	175	9,504	45,092
76/5	118	7,734	25,603

Line Item: KT73

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/2	76	12,723	15,947
73/3	86	13,180	15,506
73/4	114	16,944	23,278
74/1	127	15,118	8,986
74/2	116	12,438	15,019
74/3	103	13,398	21,648
74/4	156	20,464	57,228
75/1	216	25,571	44,863
75/2	171	21,036	54,862
75/3	156	13,865	16,758
75/4	174	25,012	82,457
76/1	188	22,813	107,644

Line Item: NS20

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/1	58	16,630	88,914
73/2	111	22,216	121,238
73/3	98	26,346	103,427
73/4	100	22,436	69,869
74/1	94	21,490	51,671
74/2	68	24,517	65,235
74/3	97	30,174	74,870
74/4	120	37,860	98,304
75/1	106	35,435	78,722
75/2	85	36,797	101,364
75/3	109	25,475	53,175
75/4	117	52,417	138,655
76/1	118	25,083	79,150
76/2	117	44,340	202,633
76/3	91	43,570	194,552
76/4	94	42,346	133,636
76/5	86	37,504	119,252

Line Item: NS17

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/1	275	113,783	354,547
73/2	275	114,486	466,321
73/3	298	114,451	592,514
73/4	271	99,002	571,384

Line Item: NS17 (cont.)

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
74/1	252	88,746	394,634
74/2	256	87,365	479,585
74/3	260	92,457	476,756
74/4	271	92,097	425,172
75/1	239	92,311	548,320
75/2	213	72,810	353,434
75/3	261	52,878	239,474
75/4	225	100,330	613,152
76/1	230	46,850	312,419
76/2	179	66,776	396,094
76/3	210	76,023	508,497
76/4	213	68,415	414,352
76/5	216	71,894	529,247

Line Item: KT71

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/1	13	3,106	22,443
73/2	10	1,905	9,382
73/3	10	2,263	21,457
73/4	6	988	1,594
74/1	10	1,665	1,487
74/2	11	1,531	-0-
74/3	14	1,721	-0-
74/4	17	2,967	-0-

Line Item: KT71 (cont.)

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
75/1	22	2,682	1,852
75/2	14	2,163	674
75/3	13	2,249	1,120
75/4	10	3,180	3,934
76/1	7	2,301	2,738
76/2	12	1,484	3,116
76/3	13	3,004	2,616
76/4	14	1,766	1,526
76/5	16	2,472	3,084

Line Item: N16

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/1	17	2,200	21,204
73/2	16	1,926	16,447
73/3	17	2,752	21,495
73/4	11	1,978	12,760
74/1	18	3,850	17,755
74/2	24	3,410	20,321
74/3	24	5,316	32,057
74/4	33	5,946	24,902
75/1	31	5,896	29,377
75/2	22	4,052	25,736
75/3	29	3,731	8,475
75/4	28	9,235	40,720

Line Item: N16 (cont.)

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
76/1	34	6,209	33,623
76/2	34	11,408	77,950
76/3	40	9,151	37,328
76/4	50	10,304	40,095
76/5	44	9,825	44,944

Line Item: G9

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/1	60	3,776	27,903
73/2	60	3,293	10,300
73/3	50	2,727	14,911
73/4	83	4,121	18,654
74/1	61	3,132	13,434
74/2	58	2,766	9,518
74/3	75	3,513	25,329
74/4	125	3,829	21,550
75/1	128	4,099	45,417
75/2	99	4,044	38,843
75/3	103	3,250	30,274
75/4	123	4,555	58,521
76/1	142	5,188	77,131
76/2	92	5,834	96,996
76/3	127	3,397	37,080
76/4	141	3,361	48,363
76/5	113	5,057	58,054

Line Item: C5A

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/3	26	7,242	54,402
73/4	31	7,084	50,255
74/1	33	9,026	39,338
74/2	45	10,348	47,121
74/3	34	9,348	21,127
74/4	30	7,994	32,476
75/1	43	13,771	51,039
75/2	42	11,957	35,866
75/3	50	12,652	39,507
75/4	54	32,132	214,940
76/1	58	12,888	58,611
76/2	58	24,016	206,755
76/3	52	18,692	86,234
76/4	40	14,023	76,981
76/5	46	17,601	129,966

Line Item: N10

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
73/1	49	18,894	28,195
73/2	55	13,051	19,072
73/3	18	10,091	8,155
73/4	13	6,542	9,582
74/1	14	5,586	10,175

Line Item: KT76

Fiscal Year/ Quarter	Number of End Items	DIRLHR	DIRMAT (1967 dollars)
75/3	-0-	188	67
75/4	24	1,479	349
76/1	19	1,477	27
76/2	30	1,500	42
76/3	35	1,810	5,419
76/4	19	1,035	3,044
76/5	19	1,406	3,644

Appendix G

Initial Regression Results

LN12	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.65642	0.50476	0.60596	0.43670	0.59750
DIRLHR/L**		0.56013		0.56839	0.89783
DIRMAT/L***					0.97238
REGRESSIONS					
LINEAR					
DW 2.17076					
R^2	0.43088	0.45827			
α^a	432.04529	0.00027			
F	179.80343	5.25855			
Sign	-0-	0.038			
β	0.0033	0.00052			
F	11.35663	0.70769			
Sign	0.004	0.414			
COBB-DOUGLAS					
DW 2.20779					
R^2			0.36718	0.37976	
α^a			4.15695	0.14664	
F			33.24618	4.26732	
Sign			-0-	0.058	
β			0.16814	0.04735	
F			8.70354	0.28398	
Sign			0.010	0.602	
VES					
DW 2.0154					
R^2			0.36718	0.37976	0.44451
α^a			4.15695	0.14664	-2.45662
F			33.24618	4.26732	1.34777
Sign			-0-	0.058	0.267
β			0.16814	0.04735	0.23345
F			8.70354	0.28398	1.51512
Sign			0.010	0.602	0.240

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

LN14	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.59648	0.48526	0.77380	0.56554	0.75740
DIRLHR/L **		0.66420		0.66619	0.96591
DIRMAT/L ***					0.83535
REGRESSIONS LINEAR					
DW 1.48641					
R^2	0.35578	0.36998			
α^a	64.69834	0.00024			
F	146.96000	2.98902			
Sign	-0-	0.106			
β	0.00029	0.00063			
F	8.28412	0.31553			
Sign	0.011	0.583			
COBB-DOUGLAS					
DW 1.76227					
R^2			0.59876	0.60327	
α^a			2.73447	0.14336	
F			66.33791	10.00162	
Sign			-0-	0.007	
β			0.15540	0.04166	
F			22.38436	0.15890	
Sign			-0-	0.696	
VES					
DW 2.06229					
R^2			0.59876	0.60327	0.66698
α^a			2.73447	0.14336	1.43593
F			66.3379	10.00162	3.06082
Sign			-0-	0.007	0.104
β			0.15540	0.04166	-0.14245
F			22.38436	0.15890	2.48700
Sign			-0-	0.696	0.139

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, a, related F, and Sign values represent change in DIRLHR/L.

LN15	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.91414	0.92295	0.54476	0.98888	0.89508
DIRLHR/L**		0.92056		0.58526	0.85049
DIRMAT/L***					0.92382
REGRESSIONS					
LINEAR					
DW 1.47056					
R^2	0.83565	0.87911			
α^a	7.36005	0.00176			
F	0.93471	1.12801			
Sign	0.371	0.337			
β	0.00380	0.00578			
F	30.50645	1.79753			
Sign	0.001	0.238			
COBB-DOUGLAS					
DW 1.12874					
R^2			0.29677	0.97965	
α^a			-1.23688	-0.04970	
F			0.19007	0.43167	
Sign			0.678	0.540	
β			0.52374	0.87350	
F			2.53204	167.76114	
Sign			0.163	-0-	
VES					
DW 1.18251					
R^2			0.29677	0.97965	0.99024
α^a			-1.23688	-0.04970	1.90465
F			0.19007	0.43167	4.10580
Sign			0.678	0.540	0.113
β			0.52374	0.8735	-0.27776
F			2.53204	167.76114	4.33972
Sign			0.163	-0-	0.106

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

VM8	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.37393	0.56535	0.40438	0.65223	0.55229
DIRLHR/L**		0.69282		0.69876	0.93962
DIRMAT/L***					0.90106
REGRESSIONS					
LINEAR					
DW 2.00330					
R^2	0.13982	0.32023			
α^a	78.55331	-0.00008			
F	19.65574	0.01249			
Sign	-0-	0.913			
β	0.00083	0.02021			
F	2.43825	3.71559			
Sign	0.139	0.074			
COBB-DOUGLAS					
DW 1.92623					
R^2			0.16352	0.43056	
α^a			1.93200	-0.06484	
F			1.51841	0.12680	
Sign			0.237	0.727	
β			0.26119	0.75824	
F			2.93231	6.56540	
Sign			0.107	0.023	
VES					
DW 1.72442					
R^2			0.16352	0.43056	0.49143
α^a			1.93200	-0.06484	5.49013
F			1.51841	0.12680	1.51745
Sign			0.237	0.727	0.240
β			0.26119	0.75824	-0.69280
F			2.93231	6.56540	1.55600
Sign			0.107	0.023	0.234

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a]When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

G200	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.30044	0.32853	0.23080	0.25799	0.26425
DIRLHR/L **		0.80895		0.83228	0.93624
DIRMAT/L ***					0.97364
REGRESSIONS					
LINEAR					
DW 2.49172					
R^2	0.09027	0.11141			
α[a]	207.90842	0.00012			
F	33.45938	0.05484			
Sign	-0-	0.818			
β	0.00035	0.00107			
F	1.48836	0.33311			
Sign	0.241	0.573			
COBB-DOUGLAS					
DW 2.60883					
R^2			0.05327	0.06740	
α[a]			4.01436	0.02900	
F			6.14594	0.01263	
Sign			0.026	0.912	
β			0.12790	0.08786	
F			0,84400	0.21214	
Sign			0.373	0.652	
VES					
DW 2.02788					
R^2			0.05327	0.06740	0.16110
α[a]			4.01436	0.02900	-3.25837
F			6.14594	0.01263	1.41427
Sign			0.026	0.912	0.256
β			0.12790	0.08786	0.32985
F			0.84400	0.21214	1.45203
Sign			0.373	0.652	0.250

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

T38	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.50773	0.95737	0.34906	0.97907	0.85226
DIRLHR/L**		0.54041		0.48459	0.78015
DIRMAT/L***					0.92483
REGRESSIONS					
LINEAR					
DW 1.94104					
R^2	0.25779	0.91668			
α^a	48.70478	-0.00008			
F	1.45568	0.01576			
Sign	0.253	0.903			
β	0.00310	0.02040			
F	3.82059	79.08111			
Sign	0.077	-0-			
COBB-DOUGLAS					
DW 2.24241					
R^2			0.12184	0.97913	
α^a			0.15350	-0.20286	
F			0.00242	9.84356	
Sign			0.965	0.011	
β			0.43211	1.12207	
F			1.52624	410.67646	
Sign			0.242	-0-	
VES					
DW 2.09603					
R^2			0.12184	0.97913	0.98130
α^a			0.15350	-0.20286	-1.18716
F			0.00242	9.84356	1.51514
Sign			0.965	0.011	0.250
β			0.43211	1.12207	0.13429
F			1.52624	410.67646	1.04624
Sign			0.242	-0-	0.333

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a]When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

TITAN	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.11813	0.05079	0.26640	0.16926	0.22313
DIRLHR/L**		0.97396		0.95475	0.99195
DIRMAT/L***					0.98453
REGRESSIONS					
LINEAR					
DW 1.91053					
R^2	0.01395	0.09429			
α[a]	34.42107	0.00032			
F	28.82776	1.41759			
Sign	-0-	0.254			
β	0.00003	-0.00156			
F	0.21227	1.24178			
Sign	0.652	0.284			
COBB-DOUGLAS					
DW 1.91153					
R^2			0.07097	0.15282	
α[a]			1.90877	0.65559	
F			1.48200	2.05207	
Sign			0.242	0.174	
β			0.14740	-0.84995	
F			1.14586	1.35267	
Sign			0.301	0.264	
VES					
DW 1.38728					
R^2			0.07097	0.15282	0.31050
α[a]			1.90877	0.65559	10.72682
F			1.48200	2.05207	3.35443
Sign			0.242	0.174	0.090
β			0.14740	-0.84995	-0.98542
F			1.14586	1.35267	2.97284
Sign			0.301	0.264	0.108

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

D7900	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	-0.40255	0.93163	-0.13034	0.98218	0.89860
DIRLHR/L**		-0.32455		-0.09170	0.27363
DIRMAT/L***					0.93217
REGRESSIONS LINEAR					
DW 1.36326					
R^2	0.16204	0.87915			
α^{a}	85.74077	-0.00014			
F	17.40139	0.74276			
Sign	0.002	0.414			
β	-0.00049	0.01080			
F	1.74042	47.47200			
Sign	0.220	-0-			
COBB-DOUGLAS					
DW 1.21611					
R^2			0.01699	0.96631	
α^{a}			6.49670	-0.07482	
F			0.98192	0.38839	
Sign			0.348	0.550	
β			-0.24014	1.00896	
F			0.15553	225.45475	
Sign			0.702	-0-	
VES					
DW 1.44975					
R^2			0.01699	0.96631	0.97185
α^{a}			6.49670	-0.07482	1.48624
F			0.98192	0.38839	1.23927
Sign			0.348	0.550	0.302
β			-0.24014	1.00896	-0.21608
F			0.15553	225.45475	1.37783
Sign			0.702	-0-	0.279

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a]When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

SR3	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.14645	0.77541	0.00940	0.95691	0.27719
DIRLHR/L**		0.27534		-0.04409	0.95925
DIRMAT/L***					0.23976
REGRESSIONS					
LINEAR					
DW 0.42410					
R^2	0.02145	0.60613			
α^a	57.58338	-0.00009			
F	29.02862	0.12353			
Sign	-0-	0.733			
β	0.00018	0.01605			
F	0.24109	14.84471			
Sign	0.633	0.003			
COBB-DOUGLAS					
DW 0.99869					
R^2			0.00009	0.91826	
α^a			3.89066	0.01800	
F			14.82915	0.32667	
Sign			0.003	0.580	
β			0.00327	1.21544	
F			0.00097	112.46153	
Sign			0.976	-0-	
VES					
DW 1.26528					
R^2			0.00009	0.91826	0.95965
α^a			3.89066	0.01800	5.90109
F			14.82915	0.32667	9.26711
Sign			0.003	0.580	0.014
β			0.00327	1.21544	-0.71586
F			0.00097	112.46153	9.21200
Sign			0.976	-0-	0.014

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

AB2171	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.55318	0.61963	0.48930	0.72662	0.75728
DIRLHR/L**		0.35386		0.36234	0.72817
DIRMAT/L***					0.90262
REGRESSIONS					
LINEAR					
DW 0.97745					
R^2	0.30601	0.51140			
α^a	333.52755	0.00209			
F	5.26566	2.34789			
Sign	0.045	0.160			
β	0.00303	0.01105			
F	4.40942	3.78329			
Sign	9.962	0.084			
COBB-DOUGLAS					
DW 0.88193					
R^2			0.23941	0.58677	
α^a			0.25297	0.28615	
F			0.00527	1.28075	
Sign			0.944	0.287	
β			0.53815	0.49821	
F			3.14776	7.56544	
Sign			0.106	0.022	
VES					
DW 2.00041					
R^2			0.23941	0.58677	0.70952
α^a			0.25297	0.28615	21.53681
F			0.00527	1.28075	3.47100
Sign			0.944	0.287	0.099
β			0.53815	0.49821	-2.13163
F			3.14776	7.56544	3.38065
Sign			0.106	0.022	0.103

* UNITSL used with DIRLHL, DIRMAL, and DIRLML
** DIRLHL used with DIRMAL and DIRLML
*** DIRMAL used with DIRLML
[a]When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

W2171	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.36520	0.79124	0.21609	0.91241	0.78500
DIRLHR/L**		0.43110		0.19821	0.69757
DIRMAT/L***					0.84051
REGRESSIONS LINEAR					
DW 0.82845					
R^2	0.13337	0.62677			
α^a	92.95313	0.00015			
F	3.99398	0.01721			
Sign	0.074	0.899			
β	0.00190	0.01708			
F	1.53898	11.89782			
Sign	0.243	0.007			
COBB-DOUGLAS					
DW 0.84796					
R^2			0.04670	0.83379	
α^a			2.41632	0.04141	
F			0.46170	0.07002	
Sign			0.512	0.797	
β			0.24395	0.87596	
F			0.48982	42.61897	
Sign			0.500	-0-	
VES					
DW 0.81776					
R^2			0.46700	0.83379	0.85433
α^a			2.41632	0.04141	9.40589
F			0.46170	0.07002	1.13757
Sign			0.512	0.797	0.317
β			0.24395	0.87596	-1.05208
F			0.48982	42.61897	1.12792
Sign			0.500	-0-	0.319

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

KT73	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.74063	0.90160	0.77595	0.88110	0.81754
DIRLHR/L **		0.82793		0.89512	0.99378
DIRMAT/L ***					0.93903
REGRESSIONS					
LINEAR					
DW 1.92026					
R^2	0.54853	0.81299			
α[a]	109.93521	-0.00002			
F	75.91840	0.00752			
Sign	-0-	0.932			
β	0.00078	0.00787			
F	17.00981	18.38454			
Sign	0.001	0.001			
COBB-DOUGLAS					
DW 1.55579					
R^2			0.60210	0.77715	
α[a]			2.00735	-0.02323	
F			9.59072	0.04763	
Sign			0.008	0.831	
β			0.28129	1.08041	
F			21.18495	10.21139	
Sign			-0-	0.007	
VES					
DW 1.55712					
R^2			0.60210	0.77715	0.77715
α[a]			2.00735	-0.02323	0.04439
F			9.59072	0.04763	0.00011
Sign			0.008	0.831	0.992
β			0.28129	1.08041	-0.00683
F			21.18495	10.21139	0.01985
Sign			-0-	0.007	0.890

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a]When DIRMAT, FIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

NS20	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.19648	0.37532	0.17511	0.43128	0.32251
DIRLHR/L**		0.70839		0.67455	0.92440
DIRMAT/L***					0.90496
REGRESSIONS					
LINEAR					
DW 1.79570					
R^2	0.03860	0.15054			
α^a	90.04302	-0.00006			
F	63.26608	0.15933			
Sign	-0-	0.696			
β	0.00008	0.00082			
F	0.60229	1.84476			
Sign	0.450	0.196			
COBB-DOUGLAS					
DW 1.83315					
R^2			0.03066	0.21061	
α^a			3.57405	-0.10526	
F			6.10662	0.43646	
Sign			0.026	0.520	
β			0.08674	0.35409	
F			0.47451	3.19147	
Sign			0.511	0.096	
VES					
DW 1.80965					
R^2			0.03066	0.21061	0.21700
α^a			3.57405	-0.10526	1.61199
F			6.10662	0.43646	0.09333
Sign			0.026	0.520	0.765
β			0.08674	0.35409	-0.16570
F			0.47451	3.19147	0.10602
Sign			0.511	0.096	0.750

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

NS17	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.12192	0.58767	0.08294	0.56142	0.38201
DIRLHR/L**		0.64020		0.65186	0.89192
DIRMAT/L***					0.92421
REGRESSIONS					
LINEAR					
DW 2.29475					
R^2	0.01486	0.50865			
α^a	227.14270	-0.00012			
F	40.26255	2.81483			
Sign	-0-	0.116			
β	0.00004	0.00133			
F	0.22634	14.06940			
Sign	0.641	0.002			
COBB-DOUGLAS					
DW 2.28515					
R^2			0.00688	0.45448	
α^a			4.91517	-0.26166	
F			7.64428	3.57482	
Sign			0.014	0.080	
β			0.04410	0.45187	
F			0.10390	11.48715	
Sign			0.752	0.004	
VES					
DW 2.10923					
R^2			0.00688	0.45448	0.68026
α^a			4.91517	-0.26166	-11.03492
F			7.64428	3.57482	9.62171
Sign			0.014	0.080	0.008
β			0.04410	0.45187	0.95668
F			0.10390	11.48715	9.17958
Sign			0.752	0.004	0.010

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F and Sign values represent change in DIRLHR/L.

KT71	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	-0.16825	0.42687	-0.24351	0.50437	-0.19974
DIRLHR/L **		0.29768		0.17067	0.99602
DIRMAT/L ***					0.24997
REGRESSIONS LINEAR					
DW 1.41044					
R^2	0.02831	0.27792			
α^a	12.88896	-0.00018			
F	130.00370	1.85545			
Sign	-0-	0.195			
β	-0.00009	0.00310			
F	0.43702	4.83950			
Sign	0.519	0.045			
COBB-DOUGLAS					
DW 1.63235					
R^2			0.05930	0.36628	
α^a			2.63216	-0.03235	
F			225.85878	2.47185	
Sign			-0-	0.138	
β			-0.02320	0.55740	
F			0.94556	6.78166	
Sign			0.346	0.021	
VES					
DW 1.67862					
R^2			0.05930	0.36628	0.36975
α^a			2.63216	-0.03235	0.11772
F			225.85878	2.47188	0.04398
Sign			-0-	0.138	0.837
β			-0.02320	0.55740	-0.01964
F			0.94556	6.78166	0.07158
Sign			0.346	0.021	0.793

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

N16	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.58919	0.85343	0.63209	0.89060	0.81341
DIRLHR/L**		0.86889		0.81751	0.93930
DIRMAT/L***					0.96498
REGRESSIONS					
LINEAR					
DW 2.48263					
R^2	0.34715	0.82311			
α^a	16.18537	-0.00041			
F	12.18262	7.49800			
Sign	0.003	0.016			
β	0.00039	0.00475			
F	7.97612	37.67130			
Sign	0.013	-0-			
COBB-DOUGLAS					
DW 2.10627					
R^2			0.39954	0.82095	
α^a			-1.73648	-0.22440	
F			1.20756	2.17166	
Sign			0.289	0.163	
β			0.49015	0.77485	
F			9.98080	32.94908	
Sign			0.006	-0-	
VES					
DW 2.12562					
R^2			0.39954	0.82095	0.83120
α^a			-1.73648	-0.22440	1.23609
F			1.20756	2.17166	0.56085
Sign			0.289	0.163	0.467
β			0.49015	0.77485	-0.16826
F			9.98080	32.94908	0.78979
Sign			0.006	-0-	0.390

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

G9	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.60172	0.46647	0.75041	0.55386	0.71366
DIRLHR/L**		0.88111		0.82090	0.98487
DIRMAT/L***					0.90680
REGRESSIONS LINEAR					
DW 1.80443					
R^2	0.36207	0.38023			
α^a	67.64530	0.00110			
F	33.22390	3.67378			
Sign	-0-	0.076			
β	0.00078	-0.01041			
F	8.51362	0.41010			
Sign	0.011	0.532			
COBB-DOUGLAS					
DW 2.20151					
R^2			0.56311	0.57496	
α^a			0.55830	0.46352	
F			0.38361	8.83410	
Sign			0.545	0.010	
β			0.38355	-0.31303	
F			19.33396	0.39018	
Sign			0.001	0.542	
VES					
DW 2.13009					
R^2			0.56311	0.57496	0.68973
α^a			0.55830	0.46352	6.95979
F			0.39361	8.83410	5.50763
Sign			0.545	0.010	0.035
β			0.38355	-0.31303	-0.79582
F			19.33396	0.39018	4.80890
Sign			00.001	0.542	0.047

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

C5A	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.60289	0.74043	0.58883	0.83080	0.71880
DIRLHR/L**		0.91838		0.83062	0.96718
DIRMAT/L***					0.94430
REGRESSIONS					
LINEAR					
DW 2.22261					
R^2	0.36348	0.58622			
α^a	34.93171	-0.00008			
F	92.04358	1.10141			
Sign	-0-	0.315			
β	0.00010	0.00180			
F	7.42344	6.45973			
Sign	0.017	0.026			
COBB-DOUGLAS					
DW 2.60405					
R^2			0.34672	0.72328	
α^a			1.24776	-0.12484	
F			1.74100	1.43364	
Sign			0.210	0.254	
β			0.22514	0.64029	
F			6.89949	16.33001	
Sign			0.021	0.002	
VES					
DW 1.79171					
R^2			0.34672	0.72328	0.79717
α^a			1.24776	-0.12484	2.64002
F			1.74100	1.43364	3.63657
Sign			0.210	0.254	0.830
β			0.22514	0.64029	-0.28703
F			6.89949	16.33001	4.00682
Sign			0.021	0.002	0.071

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

N10	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.87717	0.82749	0.90308	0.83929	0.91764
DIRLHR/L**		0.90812		0.79759	0.95434
DIRMAT/L***					0.94124
REGRESSIONS					
LINEAR					
DW 2.24788					
R^2	0.76942	0.77488			
α^a	-3.51526	0.00176			
F	0.14024	1.20108			
Sign	0.727	0.353			
β	0.00216	0.00071			
F	13.34775	0.07268			
Sign	0.022	0.805			
COBB-DOUGLAS					
DW 1.89325					
R^2			0.81556	0.85448	
α^a			-8.63549	0.88306	
F			9.56692	3.09385	
Sign			0.036	0.177	
β			1.24173	0.49524	
F			17.68745	0.80227	
Sign			0.014	0.436	
VES					
DW 1.32916					
R^2			0.81556	0.85448	0.93009
α^a			-8.63549	0.88306	19.69682
F			9.56692	3.09385	2.36813
Sign			0.036	0.177	0.264
β			1.24173	0.49524	-1.95922
F			17.68745	0.80227	2.16295
Sign			0.014	0.436	0.279

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a] When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

KT76	DIRLHR	DIRMAT	DIRLHL	DIRMAL	DIRLML
CORRELATION					
UNITSP/L *	0.43604	0.93268	0.34596	0.98867	0.50575
DIRLHR/L**		0.39127		0.31370	0.98292
DIRMAT/L***					0.47995
REGRESSIONS LINEAR					
DW 2.10511					
R^2	0.19013	0.87586			
α^a	16.92416	0.00042			
F	9.46120	0.19239			
Sign	0.028	0.684			
β	0.00219	0.01895			
F	1.17385	22.09573			
Sign	0.328	0.009			
COBB-DOUGLAS					
DW 2.69436					
R^2			0.11969	0.97889	
α^a			1.60472	0.02119	
F			1.27456	0.26967	
Sign			0.310	0.631	
β			0.18455	1.51622	
F			0.67981	162.82841	
Sign			0.447	-0-	
VES					
DW 2.08559					
R^2			0.11969	0.97889	0.98166
α^a			1.60472	0.02119	0.76673
F			1.27456	0.26967	0.47834
Sign			0.310	0.631	0.539
β			0.18455	1.51622	-0.10271
F			0.67981	162.82841	0.45297
Sign			0.447	-0-	0.549

* UNITSL used with DIRLHL, DIRMAL, and DIRLML

** DIRLHL used with DIRMAL and DIRLML

*** DIRMAL used with DIRLML

[a]When DIRMAT, DIRMAL, and DIRLML are brought into regression, α, related F, and Sign values represent change in DIRLHR/L.

Appendix H

Durbin-Watson Statistic

The Durbin-Watson statistic is calculated using the optional statistic offered in the SPSS program for regression (Nie, 1975: 356). To quote from the SPSS manual:

> The Durbin-Watson statistic is based on the differences between the residuals of adjacent cases in a <u>sequenced</u> file and is used in a test for autocorrelation.
>
> $$\text{Durbin-Watson statistic (d)} = \frac{\sum_{i=2}^{n} (e_i - e_{i-1})^2}{\sum_{i=1}^{n} e_i^2}$$
>
> where e_i is the residual for case i and n is the number of cases (Ibid).

Through use of a Durbin-Watson test statistic table, (Theil, 1971: 200) the values for lower (d_L) and upper (d_U) bounds for the five percent significance level were obtained. The test for autocorrelation states that if the computed value of d (from regression program) is greater than the corresponding value of d_U, then the successive residuals are not positively autocorrelated. Yet if the value of d is less than d_U and greater than d_L, no conclusion can be drawn. In this thesis, when d was less than d_U, the generalized correction or autoregressive transformation procedure (Theil, 1971: 254) was used to increase the value of d thus removing the positive autocorrelation. Specifically, with the 60 regression formulas used in the initial regressions, there were 20 in which autocorrelation was present (see Appendix G) and the autoregressive transformation was used. For the values used for the autoregressive transformation, see Appendix I and for the "corrected" regression

equation parameters and associated values, see Appendix J.

Appendix I

Production Data for Autoregressive Transformation

NOTE: Under the column heading <u>Quarter</u>, 1 corresponds to the first quarter of the first Fiscal year under column <u>Quarter</u> in Appendix F. The remainder of the quarters follow sequentially.

Line Item: LN14

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
2/1	20	578	53,831
3/2	0	5,000	24,499
4/3	30	4,086	67,942
5/4	6	3.950	449
6/5	37	3,100	12,585
7/6	2	1,294	63,992
8/7	0	2,699	7,769
9/8	6	1,771	17,868
10/9	23	8,314	26,868
11/10	2	4,207	5,168
12/11	16	7,288	9,978
13/12	17	4,283	3,329
14/13	1	710	7,393
15/14	4	538	1,669
16/15	2	1,600	1,224
17/16	11	659	903

Line Item: LN15

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
2/1	9	533	3,277
3/2	8	273	427

Line Item: LN15 (cont.)

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
4/3	32	1,687	8,255
5/4	14	2,549	7,526
6/5	11	422	3,117
7/6	12	30	3,112
8/7	9	803	3,874

Line Item: TITAN

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
2/1	5	2,186	3,104
3/2	1	1,112	1,920
4/3	6	3,775	28,516
5/4	3	4,645	25,052
6/5	8	2,094	5,857
7/6	11	4,077	588
8/7	7	4,926	32,947
9/8	5	585	15,548
10/9	8	4,392	24,691
11/10	9	4,413	46,285
12/11	2	18,891	77,977
13/12	33	22,311	86,271
14/13	40	22,774	114,324
15/14	5	13,218	79,116
16/15	7	3,605	17,132
17/16	2	3,600	27,591

Line Item: D7900

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
2/1	2	175	83,775
3/2	25	2,064	59,798
4/3	27	1,977	42,866
5/4	15	543	4,847
6/5	6	354	11,911
7/6	7	851	10,050
8/7	0	1,960	4,384
9/8	0	545	3,976
10/9	10	1,011	1,664
11/10	14	639	1,992

Line Item: SR3

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
2/1	76	4,329	26,148
3/2	23	1,444	38,237
4/3	21	774	70,582
5/4	27	1,269	24,906
6/5	3	569	8,895
7/6	7	639	4,271
8/7	5	535	384
9/8	16	923	7,647
10/9	13	994	13,077
11/10	9	1,408	10,586

Line Item: SR3 (cont.)

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
12/11	9	642	311
13/12	13	331	5,137

Line Item: AB2171

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
2/1	392	15,192	46,098
3/2	54	487	51,380
4/3	33	1,310	39,601
5/4	36	2,064	29,181
6/5	106	5,173	6,431
7/6	2	1,493	14,686
8/7	102	5,068	24,890
9/8	134	5,605	48,499
10/9	80	1,527	25,460
11/10	49	478	28,888
12/11	12	2,509	7,868

Line Item: W2171

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
2/1	95	4,562	11,915
3/2	18	1,913	2,138
4/3	0	1	4,553
5/4	7	825	20,928

Line Item: W2171 (cont.)

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
6/5	6	2,920	19,880
7/6	13	1,764	2,756
8/7	73	2,290	151
9/8	45	362	12,320
10/9	33	1,653	2,842
11/10	39	171	5,656
12/11	57	1,770	19,489

Line Item: KT73

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
2/1	10	457	441
3/2	28	3,764	7,772
4/3	13	1,826	14,292
5/4	11	2,680	6,033
6/5	13	960	6,629
7/6	53	7,066	35,580
8/7	60	5,107	12,365
9/8	45	4,535	9,999
10/9	15	7,171	38,104
11/10	18	11,147	65,699
12/11	14	2,199	25,187
13/12	1	1,643	32,621
14/13	4	1,573	69,886

Line Item: KT73 (cont.)

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
15/14	2	1,056	24,299
16/15	2	2,409	5,770

Line Item: KT71

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
2/1	3	1,201	13,061
3/2	0	358	12,075
4/3	4	1,275	19,863
5/4	4	677	107
6/5	1	134	1,487
7/6	3	190	0
8/7	3	1,246	0
9/8	5	285	1,852
10/9	8	519	1,178
11/10	1	86	446
12/11	3	931	2,814
13/12	3	879	1,196
14/13	5	817	378
15/14	1	1,520	500
16/15	1	1,238	1,090
17/16	2	706	1,558

Line Item: N10

Quarter (t_i/t_{i-1})	UNITSF	DIRLHF	DIRMAF
2/1	6	5,843	9,123
3/2	37	2,960	10,917
4/3	5	3,549	1,427
5/4	1	956	593

Appendix J

Initial Regressions after Autoregressive Transformation

LN14	DIRLHF	DIRMAF	DIRLHFL	DIRMAFL	DIRLMLF
CORRELATION					
UNITSF/L *	0.72685	0.64051	0.52057	0.49277	0.63258
DIRLHF/L**		0.71148	0.85442	0.47491	0.78882
DIRMAF/L***			0.45250	0.80627	0.82081
REGRESSIONS					
LINEAR					
DW 2.90939					
R^2	0.52830	0.55913			
α^a	2.82123	0.00213			
F	0.45646	4.38988			
Sign	0.510	0.056			
β	0.00282	0.00009			
F	15.68012	0.90887			
Sign	0.001	0.358			
COBB-DOUGLAS					
DW 2.72518					
R^2			0.14346	0.15879	
α^a			-2.11802	0.44521	
F			0.63893	1.44388	
Sign			0.437	0.251	
β			0.51219	0.10480	
F			2.34490	0.23679	
Sign			9.148	0.635	
VES					
DW 2.66025					
R^2			0.14346	0.15879	0.17779
α^a			-2.11802	0.44521	-0.53865
F			0.63893	1.44388	0.07982
Sign			0.437	0.251	0.782
β			0.51219	0.10480	0.10207
F			2.34490	0.23679	0.27738
Sign			0.148	0.635	0.608

* UNITSL used with DIRLHFL, DIRMAFL, and DIRLMLF

** DIRLHFL used with DIRMAFL and DIRLMLF

*** DIRMAFL used with DIRLMLF

a When DIRMAF, DIRMAFL, and DIRLMLF enter the regression, α, related F, and Sign values represent change in DIRLHF/L.

LN15	DIRLHF	DIRMAF	DIRLHFL	DIRMAFL	DIRLMLF
CORRELATION					
UNITSF/L *	0.51727	0.77904	0.39517	0.57357	0.53355
DIRLHF/L **		0.87010	0.82608	0.64993	0.89327
DIRMAF/L ***			0.65597	0.88814	0.84797
REGRESSIONS					
LINEAR					
DW 1.54541					
R^2	0.26757	0.71302			
α^a	9.23738	-0.00616			
F	4.46549	1.47914			
Sign	0.088	0.291			
β	0.00482	0.00414			
F	1.82661	6.20876			
Sign	0.234	0.067			
COBB-DOUGLAS					
DW 1.84635					
R^2			0.14366	0.44382	
α^a			1.73688	0.03014	
F			4.20957	0.04917	
Sign			0.095	0.835	
β			0.12249	0.29702	
F			0.83883	2.15870	
Sign			0.402	0.216	
VES					
DW 3.06669					
R^2			0.14366	0.44382	0.69025
α^a			1.73688	0.03014	-3.66678
F			4.20957	0.04917	2.34229
Sign			0.095	0.835	0.223
β			0.12249	0.29702	0.44179
F			0.83883	2.158701	2.38666
Sign			0.402	0.216	0.220

* UNITSL used with DIRLHFL, DIRMAFL, and DIRLMLF

** DIRLHFL used with DIRMAFL and DIRLMLF

*** DIRMAFL used with DIRLMLF

[a] When DIRMAF, DIRMAFL, and DIRLMLF enter the regression, α, related F, and Sign values represent change in DIRLHF/L.

TITAN	DIRLHF	DIRMAF	DIRLHFL	DIRMAFL	DIRLMLF
CORRELATION					
UNITSF/L *	0.72563	0.67004	0.58846	0.36997	0.53251
DIRLHF/L**		0.93757	0.90258	0.65298	0.86221
DIRMAF/L***			0.86538	0.82367	0.93965
REGRESSIONS					
LINEAR					
DW 2.59691					
R^2	0.52654	0.52742			
α^a	1.80210	0.00117			
F	0.42648	2.15837			
Sign	0.524	0.166			
β	0.00106	-0.00003			
F	15.56982	0.02409			
Sign	0.001	0.879			
COBB-DOUGLAS					
DW 2.35523					
R^2			0.22732	0.22822	
α^a			-1.89851	0.46410	
F			1.06549	2.43421	
Sign			0.319	0.143	
β			0.44014	-0.02528	
F			4.11881	0.01516	
Sign			0.062	0.904	
VES					
DW 2.31805					
R^2			0.22732	0.22822	0.23644
α^a			-1.89851	0.46410	1.30871
F			1.06549	2.43421	0.30486
Sign			0.319	0.143	0.591
β			0.44014	-0.02528	-0.08103
F			4.11881	0.01516	0.12915
Sign			0.062	0.904	0.726

* UNITSL used with DIRLHFL, DIRMAFL, and DIRLMLF

** DIRLHFL used with DIRMAFL and DIRLMLF

*** DIRMAFL used with DIRLMLF

a When DIRMAF, DIRMAFL, and DIRLMLF enter the regression, α, related F, and Sign values represent change in DIRLHF/L.

D7900	DIRLHF	DIRMAF	DIRLHFL	DIRMAFL	DIRLMLF
CORRELATION					
UNITSF/L *	0.53215	0.27231	0.52641	0.33951	0.65823
DIRLHF/L**		0.94570	0.94570	0.21788	0.80369
DIRMAF/L***			-0.16012	0.92215	0.57826
REGRESSIONS					
LINEAR					
DW 1.07728					
R^2	0.28319	0.32583			
α^a	3.37883	0.00678			
F	0.47511	2.61315			
Sign	0.510	0.150			
β	0.00714	0.00007			
F	3.16052	0.44271			
Sign	0.113	0.527			
COBB-DOUGLAS					
DW 1.11230					
R^2			0.11642	0.15083	
α^a			-1.60615	0.53544	
F			0.22342	1.01209	
Sign			0.649	0.348	
β			0.52069	0.16343	
F			1.05408	0.28367	
Sign			0.335	0.611	
VES					
DW 1.73832					
R^2			0.11642	0.15083	0.43460
α^a			-1.60615	0.53544	-6.52708
F			0.22342	1.01209	2.53826
Sign			0.649	0.348	0.162
β			0.52069	0.16343	0.68267
F			1.05408	0.28367	3.01126
Sign			0.335	0.611	0.133

* UNITSL used with DIRLHFL, DIRMAFL, and DIRLMLF

** DIRLHFL used with DIRMAFL and DIRLMLF

*** DIRMAFL used with DIRLMLF

[a] When DIRMAF, DIRMAFL, and DIRLMLF enter the regression, α, related F, and Sign values represent change in DIRLHF/L.

SR3	DIRLHF	DIRMAF	DIRLHFL	DIRMAFL	DIRLMLF
CORRELATION					
UNITSF/L *	0.94445	0.37757	0.82671	0.45977	0.69144
DIRLHF/L**		0.23963	0.92179	0.39507	0.68136
DIRMAF/L***			0.33861	0.76235	0.69314
REGRESSIONS					
LINEAR					
DW 1.76184					
R^2	0.89198	0.91625			
α^a	-1.59151	0.01669			
F	0.29196	83.14531			
Sign	0.601	-0-			
β	0.01740	0.00015			
F	82.57512	2.60849			
Sign	-0-	0.141			
COBB-DOUGLAS					
DW 1.63087					
R^2			0.55113	0.60733	
α^a			-3.98713	0.77998	
F			4.51080	6.16840	
Sign			0.060	0.035	
β			0.96118	0.14058	
F			12.27827	1.28809	
Sign			0.006	0.286	
VES					
DW 2.14896					
R^2			0.55113	0.60733	0.70166
α^a			-3.98713	0.77998	-5.32827
F			4.51080	6.16840	1.91377
Sign			0.060	0.035	0.204
β			0.96118	0.14058	0.62413
F			12.27827	1.28809	2.52945
Sign			0.006	0.286	0.150

* UNITSL used with DIRLHFL, DIRMAFL, and DIRLMLF

** DIRLHFL used with DIRMAFL and DIRLMLF

*** DIRMAFL used with DIRLMLF

[a] When DIRMAF, DIRMAFL, and DIRLMLF enter the regression, α, related F, and Sign values represent change in DIRLHF/L.

AB2171	DIRLHF	DIRMAF	DIRLHFL	DIRMAFL	DIRLMLF
CORRELATION					
UNITSF/L *	0.95549	0.42008	0.72221	0.34264	0.83822
DIRLHF/L **		0.24279	0.86842	0.15511	0.88561
DIRMAF/L ***			-0.03956	0.95882	0.42077
REGRESSIONS					
LINEAR					
DW 1.88704					
R^2	0.91296	0.95056			
α^a	0.43334	0.02309			
F	0.00099	125.25056			
Sign	0.976	-0-			
β	0.02433	0.00137			
F	94.40276	6.08309			
Sign	-0-	0.039			
COBB-DOUGLAS					
DW 2.81650					
R^2			0.24046	0.46354	
α^a			-1.07633	0.71288	
F			0.13212	4.36924	
Sign			0.725	0.070	
β			0.64156	0.92701	
F			2.84927	3.32669	
Sign			0.126	0.106	
VES					
DW 1.60545					
R^2			0.24046	0.46354	0.64794
α^a			-1.07633	0.71288	14.19521
F			0.13212	4.36924	4.05735
Sign			0.725	0.070	0.084
β			0.64156	0.92701	-1.28315
F			2.84927	3.32669	3.66650
Sign			0.126	0.106	0.097

* UNITSL used with DIRLHFL, DIRMAFL, and DIRLMLF

** DIRLHFL used with DIRMAFL and DIRLMLF

*** DIRMAFL used with DIRLMLF

[a] When DIRMAF, DIRMAFL, and DIRLMLF enter the regression, α, related F, and Sign values represent change in DIRLHF/L.

W2171	DIRLHF	DIRMAF	DIRLHFL	DIRMAFL	DIRLMLF
CORRELATION					
UNITSF/L *	0.54059	-0.05772	0.43084	-0.20309	0.28477
DIRLHF/L**		0.12813	0.70103	-0.02385	0.62955
DIRMAF/L***			0.19318	0.83708	0.57410
REGRESSIONS					
LINEAR					
DW 1.23043					
R^2	0.29224	0.30863			
α [a]	14.66910	0.01270			
F	1.20546	3.53268			
Sign	0.301	0.097			
β	0.01232	-0.00050			
F	3.71610	0.18970			
Sign	0.086	0.675			
COBB-DOUGLAS					
DW 0.90603					
R^2			0.45814	0.48728	
α [a]			0.47493	0.38435	
F			0.23976	7.02732	
Sign			0.636	0.029	
β			0.38745	-0.15923	
F			7.60953	0.45457	
Sign			0.022	0.519	
VES					
DW 0.84168					
R^2			0.45814	0.48728	0.52407
α [a]			0.47493	0.38435	3.39832
F			0.23976	7.02732	0.68706
Sign			0.636	0.029	0.435
β			0.38745	-0.15923	-0.35531
F			7.60953	0.45457	0.54116
Sign			0.022	0.519	0.486

* UNITSL used with DIRLHFL, DIRMAFL, and DIRLMLF

** DIRLHFL used with DIRMAFL and DIRLMLF

*** DIRMAFL used with DIRLMLF

a When DIRMAF, DIRMAFL, and DIRLMLF enter the regression, α, related F, and Sign values represent change in DIRLHF/L.

KT73	DIRLHF	DIRMAF	DIRLHFL	DIRMAFL	DIRLMLF
CORRELATION					
UNITSF/L *	0.48706	-0.12640	0.57178	0.03756	0.32632
DIRLHF/L **		0.48709	0.91353	0.47927	0.81120
DIRMAF/L ***			0.38407	0.81688	0.72178
REGRESSIONS					
LINEAR					
DW 1.13290					
R^2	0.23723	0.41060			
α^a	8.21814	0.00457			
F	1.35978	8.03427			
Sign	0.265	0.015			
β	0.00309	-0.00042			
F	4.04309	3.52970			
Sign	0.66	0.085			
COBB-DOUGLAS					
DW 1.61833					
R^2			0.29064	0.49078	
α^a			-3.62386	1.20210	
F			1.90418	11.46548	
Sign			0.191	0.005	
β			0.76705	-0.52439	
F			5.32640	4.71638	
Sign			0.038	0.051	
VES					
DW 1.63242					
R^2			0.29064	0.49078	0.49270
α^a			-3.62386	1.20210	0.80889
F			1.90418	11.46548	0.16997
Sign			0.191	0.005	0.688
β			0.76705	-0.52439	0.04016
F			5.32640	4.71638	0.04164
Sign			0.038	0.051	0.842

* UNITSL used with DIRLHFL, DIRMAFL, and DIRLMLF

** DIRLHFL used with DIRMAFL and DIRLMLF

*** DIRMAFL used with DIRLMLF

a When DIRMAF, DIRMAFL, and DIRLMLF enter the regression, α, related F, and Sign values represent change in DIRLHF/L.

KT71	DIRLHF	DIRMAF	DIRLHFL	DIRMAFL	DIRLMLF
CORRELATION					
UNITSF/L *	-0.01662	-0.06104	0.15773	-0.06357	-0.00415
DIRLHF/L**		0.25855	0.94212	0.10076	0.34380
DIRMAF/L***			0.24617	0.61050	0.65903
REGRESSIONS					
LINEAR					
DW 2.08856					
R^2	0.00028	0.00373			
α^a	2.99239	-0.00001			
F	8.51924	0.00001			
Sign	0.011	0.998			
β	-0.00007	-0.00002			
F	0.00387	0.04502			
Sign	0.951	0.835			
COBB-DOUGLAS					
DW 1,87457					
R^2			0.05809	0.07820	
α^a			-0.31142	0.20496	
F			0.05689	0.94128	
Sign			0.815	0.350	
β			0.18937	-0.03461	
F			0.86343	0.28365	
Sign			0.369	0.603	
VES					
DW 1.64291					
R^2			0.05809	0.07820	0.10645
α^a			-0.31142	0.20496	-0.07834
F			0.05689	0.94128	0.02374
Sign			0.815	0.350	0.880
β			0.18937	-0.03461	0.04756
F			0.86343	0.28365	0.37928
Sign			0.369	0.603	0.549

* UNITSL used with DIRLHFL, DIRMAFL, and DIRLMLF
** DIRLHFL used with DIRMAFL and DIRLMLF
*** DIRMAFL used with DIRLMLF
[a] When DIRMAF, DIRMAFL, and DIRLMLF enter the regression, α, related F, and Sign values represent change in DIRLHF/L.

N10	DIRLHF	DIRMAF	DIRLHFL	DIRMAFL	DIRLMLF
CORRELATION					
UNITSF/L *	0.00255	0.74641	0.18723	0.68415	0.52979
DIRLHF/L**		0.56220	0.96021	0.69854	0.84185
DIRMAF/L***			0.60229	0.97843	0.90713
REGRESSIONS LINEAR					
DW 2.04892					
R^2	0.00001	0.81148			
α^a	12.17982	-0.00504			
F	0.30733	1.34923			
Sign	0.635	0.453			
β	0.00002	0.00344			
F	0.00001	4.30452			
Sign	0.997	0.286			
COBB-DOUGLAS					
DW 1.92726					
R^2			0.34179	0.73723	
α^a			-7.19739	-0.25527	
F			0.66691	0.02891	
Sign			0.500	0.893	
β			1.12928	0.98903	
F			1.03855	1.50486	
Sign			0.415	0.435	
VES					
DW 1.95914					
R^2			0.34179	0.73723	1.00000
α^a			-7.19739	-0.25527	8.07815
F			0.66691	0.02891	-0-
Sign			0.500	0.893	1.00000
β			1.12928	0.98903	-1.15152
F			1.03855	1.50486	-0-
Sign			0.415	0.435	1.00000

* UNITSL used with DIRLHFL, DIRMAFL, and DIRLMLF

** DIRLHFL used with DIRMAFL and DIRLMLF

*** DIRMAFL used with DIRLMLF

a When DIRMAF, DIRMAFL, and DIRLMLF enter the regression, α, related F, and Sign values represent change in DIRLHF/L.

VITA

Donny Ray Jones was born on 29 June, 1950, in Brunswick, Georgia. After graduating from Glynn Academy High School in Brunswick, in 1968, he entered the United States Air Force Academy, Colorado Springs, Colorado. He graduated and received his commission in the Air Force in June, 1972. After serving as Aircraft Maintenance Officer in the 87th Fighter Interceptor Squadron (ADCOM), K. I. Sawyer AFB, Michigan for four years, he began graduate study at the Air Force Institute of Tecnology in June, 1976.

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Job Satisfaction
Productivity

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The relationship between job satisfaction and productivity is one that has received considerable attention recently. Developing a method of measuring this relationship across an organization, without interrupting the production process, requires a careful analysis of available information. This thesis studied the Aerospace Guidance and Metrology Center, Newark AFS, Ohio.

Production data in the form of units produced, direct labor hours, and direct material costs (in 1967 dollars) were used. The

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production data used covered twenty (20) line items that are repaired at Newark AFS. This production data was used to develop production functions. Through the use of regression techniques, marginal products were determined. These marginal products were then standardized in order to reduce the effect of the magnitude of the values involved, putting the marginal products in the form of elasticities.

A questionnaire was developed so that a measure of job satisfaction could be derived, to be used in the final analysis.

In the final analysis the marginal products were used with the job satisfaction questionniare responses to determine what type, if any, relationship there was between job satisfaction and productivity, as measured at Newark AFS.